AMERICAN
DYESTUFF REPORTER
Volume 47 January 27, 1958 Number 2

FAST DYES ON CELLULOSIC FIBERS*

T VICKERSTAFF
Imperial Chemical Industries Ltd
Manchester 9, England

INTRODUCTION

ONE of the main preoccupations of the dyer always has been the achievement of fast dyeings, but the present paper is concerned mainly with the problem of wetfastness on cellulosic fibers. From the theoretical point of view, wetfastness can be obtained in two ways, namely:

1) The introduction into the fiber of insoluble coloring matters. Wetfastness is then attained by the mechanical retention of the pigment particles within the fiber, coupled with the insolubility of the pigment in soap solutions. Typical examples of this method are the mass pigmentation of rayons and the use of vat, azoic, phthalogen and Alcian dyes.

2) The use of soluble dyes, which are designed to have an appreciable affinity for the fiber. The classical example of this method is the direct dyes, where the molecular structure of the dye is selected so that physical absorption forces of considerable strength are built up between dye and fiber.

The simplicity of application of water-soluble dyes has always been attractive, but in order to achieve any significant wetfastness, the soluble dyes must have a high affinity for cellulose. Simple acid wool dyes have negligible affinity and are completely removed by washing, and the higher affinity of direct dyes is obtained by building up long, flat molecules. These molecules must be linear and must be large, which means in effect that polyazo structures must be used. Consequently, many attractive chromophoric systems, such as anthraquinone dyes and triphenyl methane dyes, are ruled out, while the complexity of a polyazo system almost inevitably introduces dullness. Direct dyes are therefore somewhat limited in their brightness and range of shades. Furthermore, large molecules diffuse into cellulose very slowly so that if a direct dye molecule is made larger to increase its affinity and wetfastness, it becomes increasingly difficult to level, and dyeing temperatures near the boil must be used in order to obtain penetration of the fiber in a reasonable time. Finally, direct dyeing must remain fundamentally a reversible adsorption process, and since the adsorbed dye remains unchanged and water-soluble, the highest degree of wetfastness must remain unattainable.

APPLICATION OF REACTIVE DYES

The recent introduction of chemically reactive dyes opens an entirely new approach to this problem. The principle involved is very simple and consists merely of attaching to a water-soluble dye molecule a reactive group which is capable of entering into chemical combination with cellulose. With such a system it is possible to use dyes which have little or no affinity for cellulose. Consequently, simple dye molecules can be employed and theoretically any shape of chromophoric system. The dye molecule can be small and thus able to diffuse within the fiber quickly to give rapid penetration and good leveling. Once within the fiber, however, the reactive group will combine with cellulose and will anchor the dyestuff to give a high degree of wetfastness.

These principles are employed in the Procion dyes. The dyes at present available are simple mono-azo, anthraquinone, or phthalocyanine derivatives, which are polysulfonated to give high solubility. With the exception of the phthalocyanine derivative, they are of small molecular size, diffuse very rapidly within the fiber, and are therefore suitable for cold dyeing and continuous processing. To the dye molecule is attached the reactive group, which contains one or two reactive chlorine atoms. In alkaline solution, reaction between the dye and the hydroxyl groups in cellulose can occur to link the dye to the fiber by a definite chemical bond. These dyes do therefore combine the simplicity of application of water-soluble dyes with high wetfastness properties to an extent which has not hitherto been attainable.

THEORY OF DYEING WITH REACTIVE DYES

The evidence for the existence of chemical linkages within Procion-dyed fibers has been reviewed elsewhere (*1*) and the practical methods of dyeing have also been described (*2*). Consequently attention will be directed in this paper towards the theoretical aspects of the application of reactive dyes and the implications in terms of practical dyeing methods.

In the first place, the use of reactive dyes introduces a new characteristic into the dyeing operation. Dyeing behavior is no longer controlled solely by rate of diffusion and affinity but also involves reaction rates. Any dye which will react with cellulose will almost certainly react with water so that in any dyeing operation two competing reactions must be taking place, namely:-

(1) $NaSO_3$-D-Cl + HO-cellulose → $NaSO_3$-D-O-cellulose + HCl.
(2) $NaSO_3$-D-Cl + HOH → $NaSO_3$-D-OH + HCl.

Reaction (1) is the desired reaction with the fiber. Reaction (2) is a side reaction leading to inactivation of the dye, since the hydroxyl derivative formed will not react with cellulose. The relative speeds of these

*Presented before the American Chemical Society at New York, N Y.

two reactions are obviously of vital importance, and reaction (1) must be much faster than (2) if the dyes are to be of practical value.

RELATIVE RATES OF REACTION WITH CELLULOSE AND WATER——Attempts to determine quantitatively the rates of reaction of Procion Brilliant Red 2BS with cellulose have so far failed completely, except in so far as they establish that the reaction is very rapid. Pieces of viscose film (Diophane PT 300) were dyed to equilibrium in a neutral solution of Procion Brilliant Red 2BS (0.33 g/l) and common salt (30 g/l) at 30°C. Under these conditions no reaction with the fiber occurred and all the dye could be removed by treatment in boiling Lissapol NC solution. The pieces of dyed film were immersed for short times ranging from 15 seconds to 12 minutes in a cold solution of sodium carbonate (10 g/l) and salt (30 g/l) and then transferred immediately to boiling Lissapol NC solution (2 ml/l) and boiled for 10 minutes. The film was then squeezed on to a glass plate and its optical density measured at 538 mμ. The results in Table I show no significant change in density with time so that reaction must be complete in less than 15 seconds.

A similar experiment was carried out by air drying the dyed film and then suspending the film in ammonia vapor for short times before washing off. The results are shown in Table II.

Again the results show no increase in fixation beyond the shortest practicable time of treatment so that again the reaction of the absorbed reactive dye with cellulose when the environment is made alkaline must be extremely rapid.

The rate of reaction of these dyes with water is more easily measured. To stirred solutions of the dyes, alkali was added and samples removed at various times. The samples were immediately diluted and buffered to pH 6.4 to stop the reaction, and then measured on a spectrophotometer without delay. It was found that the absorption spectra of the initial reactive dye and the inactivated hydroxy derivative differed sufficiently to enable the proportions of the two forms to be measured, although the accuracy is not high owing to the small differences in optical density which are involved. In all the experiments it was found that the kinetics of decomposition were those of a first order reaction in that a straight line was obtained by plotting the logarithm of the concentration of reactive dye remaining in solution at any time against the time. An example is shown in Figure 1. From the slope of the line, the velocity constant K of this hydrolysis reaction may be calculated. Results obtained at different hydrogen ion concentrations, electrolyte concentrations, and temperatures are summarized in Tables III, IV and V.

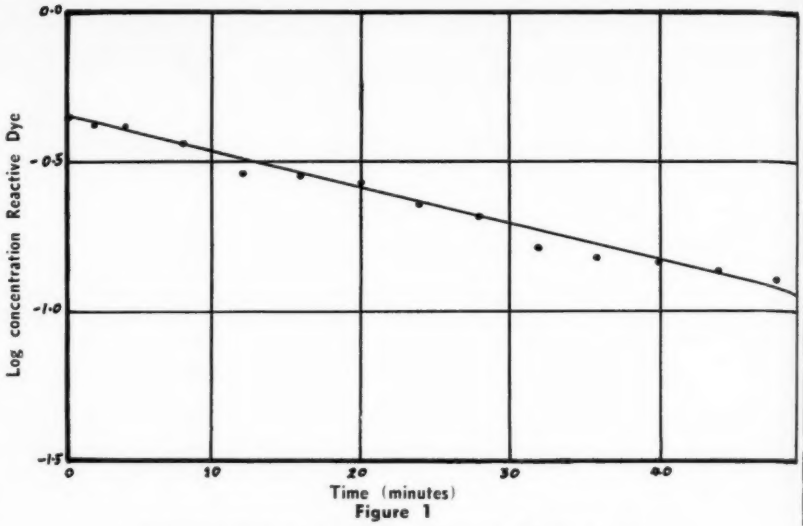


Figure 1

Rate of hydrolysis of Procion Brilliant Red 2BS at 25°C

TABLE I

Rate of reaction of Procion Brilliant Red 2BS with cellulose in soda ash solution

Time of Treatment	15 secs	30 secs	45 secs	1 min	4 min	12 min
Optical Density	0.175	0.169	0.165	0.169	0.174	0.174

TABLE II

Rate of reaction of Procion Brilliant Red 2BS with cellulose in ammonia vapor

Time of Treatment	0	5 secs	10 secs	15 secs	1 min	16 min
Optical Density	0.020	0.093	0.090	0.091	0.091	0.084

TABLE III

Effect of pH on hydrolysis of Procion Brilliant Red 2BS in water at 25°C

(Dye concentration = 0.33 g/l)

Conditions	Measured pH	Velocity Constant K
4 g/l Na_2CO_3, 0.91 g/l HCl	10.1	0.005
5 g/l Na_2CO_3	11.1	0.030
4.5 g/l Na_2CO_3, 0.5 g/l NaOH	11.8	0.054
2 g/l NaOH	12.7	0.175

TABLE IV

Effect of electrolyte concentration on hydrolysis of Procion Brilliant Red 2BS in water

(Dye concentration = 0.33 g/l)

Temp	Conditions	Measured pH	Velocity Constant K
25°C	5 g/l Na_2CO_3	11.1	0.030
25°C	10 g/l Na_2CO_3, 30 g/l NaCl	11.1	0.048
25°C	20 g/l Na_2CO_3, 60 g/l NaCl	11.1	0.074

TABLE V

Effect of temperature on the hydrolysis of Procions Brilliant Red 2BS and Blue 3GS

(Dye concentration = 0.33 g/l; Na_2CO_3 = 10 g/l; NaCl = 30 g/l)

	Procion Brilliant Red 2BS		Procion Blue 3GS	
Temp	pH	K	pH	K
25° C	11.1	0.048	11.1	0.013
30° C	11.1	0.10	10.95	0.023
35° C	11.1	0.14	10.85	0.052

These results show clearly that the rate of hydrolysis increases rapidly with increasing pH and with increasing temperature and to a lesser degree increases with increasing electrolyte concentration. They also show that Procion Brilliant Red 2BS is much more easily hydrolyzed than Procion Blue 3GS.

The importance of decomposition in alkaline solution depends on the method of application. If the Procion dyes are applied by padding in a continuous dyeing process, then the dye and alkali are taken up together by the fibers and when subsequently dried or steamed, reaction takes place so much more rapidly with the fiber than with water that good fixation is obtained. Nevertheless, some portion of the dye does react with the water in the fiber and the unfixed inactive dye must be removed by thorough washing in order that the full wetfastness of the fixed dye can be revealed. The main importance of decomposition in solution in continuous processes is therefore the stability of the padding liquor. One way of increasing this stability is to use sodium bicarbonate as the alkali, solutions being stable for several hours in the cold under such conditions. This mild alkali is sufficient to produce fixation if a subsequent heat treatment is involved or if the goods are allowed to remain in the wet condition for several hours or conveniently, overnight. Where more rapid fixation at room temperature is required, sodium carbonate must be employed and the only method of obtaining solution stability is to keep the dye and alkali in separate solutions until just before they are applied to the cloth. For example, the two solutions may be fed separately to the padding trough. Special bazaar dyeing and printing methods have been devised for the Eastern markets based on this principle.

Where decomposition in the dyebath is of much greater importance, however, is in batch dyeing. The general recommendation is to commence dyeing in a cold neutral solution of the Procion dyes containing some salt, and then after about 30 minutes, to add a mild alkali, such as sodium carbonate, trisodium phosphate or sodium silicate, sufficient to produce a pH of about 11, and continue dyeing for a further hour. It is apparent that some dyeing takes place in neutral solution but the absorbed dye is not fixed and can be washed out of the fiber by water at this stage. It is also clear that the affinity of the dyes is low, as shown by the poor exhaustion in neutral solution, which means that very good leveling is shown throughout this stage of the process. Such a low exhaustion would be uneconomic. When the alkali is added, all the dye already on the fiber is very rapidly fixed. This upsets the equilibrium which existed between the dye in the fiber and in the bath, and further diffusion of dye into the fiber begins. The new reactive dye entering the fiber may be expected to be fixed as soon as it enters so that the additional dyeing should take place almost entirely in a thin layer of fiber near the surface. The real existence of this phenomenon can be seen by examination of cross-sections of fibers dyed under appropriate conditions. To exaggerate the effect for illustration, viscose yarn was impregnated with a solution of Procion Brilliant Orange G containing sodium bicarbonate and allowed to stand in a wet condition in a closed bottle for 24 hours at room temperature, and then washed thoroughly. Under these conditions, the dye can penetrate the whole of the fiber before reaction occurs and is then fixed in situ to give a uniformly dyed fiber. This corresponds fairly closely to the conditions of most continuous dyeing processes and to the pad-roll process. In the second place, the yarn was immersed in a cold dyebath containing dye and sodium carbonate and dyed for 3 hours at room temperature before washing. Since the alkali was present at the beginning of the dyeing process, fixation should occur as soon as the dye enters the fiber and severe ring dyeing should be obtained. The photomicrographs in Figure 2 confirm these expectations.

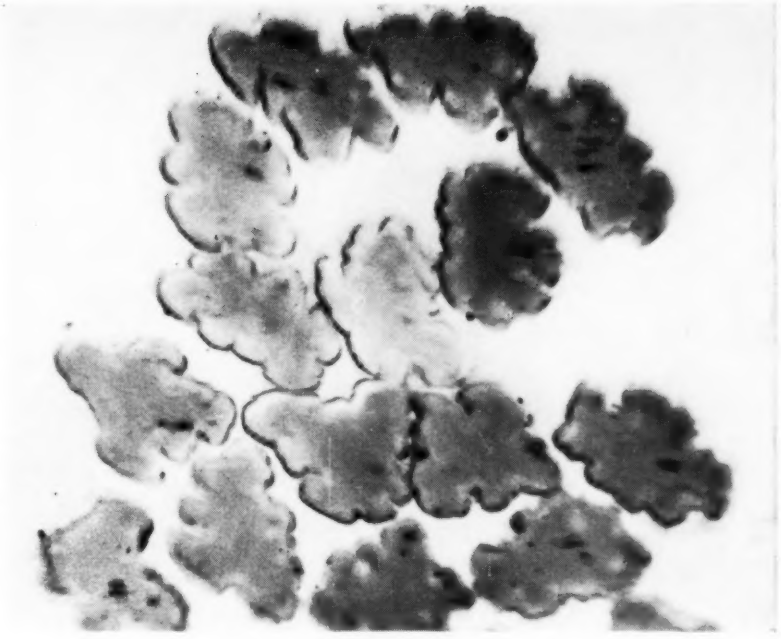


Figure 2a
Viscose fiber dyed with Procion Brilliant Orange G by impregnation and cold fixation

It should be emphasized that, in the recommended practical batch dyeing methods, alkali is not present in the initial stages, so that the dye absorbed from neutral solution will penetrate the fiber and fix in situ on addition of alkali. Under such conditions, therefore, distribution of dye through the fiber will be intermediate between that shown in the two illustrations and will approach more closely to uniform distribution the better the degree of exhaustion obtained before alkali addition.

It should be noted also that, since the dye is chemically combined with the fiber, it cannot diffuse out again and therefore the existence of ring dyeing will not adversely affect the wetfastness properties of the dyed fiber as it would with a direct dye. This has been confirmed by washing tests on the samples used for the preparation of the photomicrographs. It is obvious also that no leveling can occur after alkali has been added to the bath in batch dyeing.

Returning to the more theoretical aspects of the dyeing process, it is clear that, in the second phase of the batch dyeing process, the reactive dye in the alkaline bath will also be reacting with water, so that the extent to which dyeing by fixation occurs will depend on the relative rates of diffusion into the fiber and decomposition in the bath. In other words, in this stage it is a question of probability as to whether a reactive dye mole-

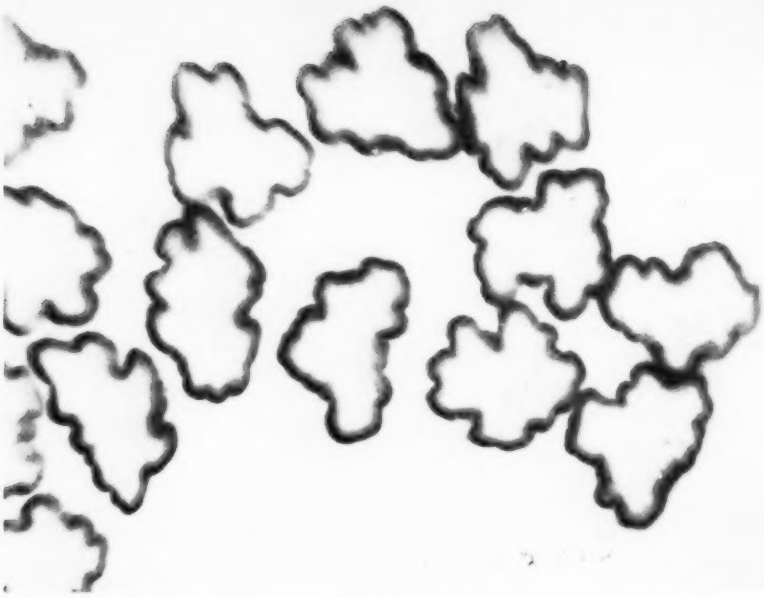


Figure 2b
Viscose fiber dyed with Procion Brilliant Orange G from an alkaline dyebath

cule can diffuse to and into the fiber before it collides with an active hydroxyl ion and is destroyed.

The importance of decomposition in batch dyeing can only be assessed from a knowledge of the rates of diffusion and decomposition. The measurement of the latter has already been described. The rate of diffusion was studied in viscose film. The film was squeezed on to a glass plate which formed one wall of a cell filled with dye solution. Inlet and outlet tubes were fitted to the cell and a pump arranged to circulate dye liquor through the cell continuously from a large reservoir. The volume of the reservoir was such that the total dyebath concentration of reactive and inactive dye could be regarded as constant. The total optical density of the cell containing dye solution and viscose film was measured at intervals at the isosbestic wavelength. Any increase in density was attributed to uptake of dye by the film, and the process was treated as diffusion from one side into an infinite slab. Applying the usual diffusion equations based on Fick's Law, diffusion coefficients were calculated for the intermediate times of the experiments. Data obtained at very short times or at long times gave unsatisfactory results owing to the experimental inaccuracy in determining small amounts of dye uptake or small changes in the uptake.

These experiments were carried out in neutral solution to determine the diffusion of the reactive dye in absence of complicating reaction with the fiber. In addition, similar experiments were carried out with completely inactivated dye, ie, the hydroxyl instead of the chloro derivative. The results are shown in Table VI. It will be seen that the diffusion coefficients of both the reactive and inactive forms of Procion Brilliant Red 2BS are very similar, as would be expected since the molecular size and shape of the two forms are nearly the same, although the reactive dye is more sensitive to temperature.

TABLE VI
Diffusion of Procions Brilliant Red 2BS and Blue 3GS into viscose film
(0.33 g/l dye; 30 g/l salt; wet thickness of film 3.3 x 10^{-2} cm)

Dye	Diffusion Coefficient (cm^2/min x 10^7)		
	25°C	30°C	35°C
Procion Brilliant Red 2BS	1.7	2.4	3.5
Inactive form of Red 2BS	1.4	1.6	2.0
Procion Blue 3GS	1.0	1.2	1.5

In order to assess the practical significance of diffusion and hydrolysis, a preliminary attempt has been made to develop a simple theory of the dyeing process. It is assumed that diffusion of dye into the fiber takes place according to Fick's Law, the reactive and inactive species being indistinguishable in this process. The fate of the reactive dye entering the fiber is governed by the relative rates of the hydrolysis and fixation reactions within the fiber. If the two reaction constants are designated by K and F respectively, it can be shown that, at an infinite time later, the proportion of reactive dye which is fixed to the fiber will be $\frac{F}{F+K}$. From the preceding data it is obvious that, in sodium carbonate solution about pH 10, F must be very much greater than K so that this fraction reduces to unity. In other words, under these conditions all the reactive dye which enters the fiber will be fixed. This simplification may not apply under less alkaline conditions, as will be seen later.

Diffusion *into* the fiber, however, is a much slower process and comparable in speed with the rate of hydrolysis. Hence diffusion into the fiber takes place from a dyebath in which the concentration of *reactive* dye is steadily decreasing even in the case of an infinite dyebath. The proportion of reactive dye remaining at any time (t) will be given by C_0e^{-Kt} where C_0 is the initial concentration. Hence the amount of dye fixed at equilibrium may be calculated from Hill's equation for diffusion into cylindrical fibers modified by the decrease in external concentration. Using the diffusion coefficients and hydrolysis constants already determined, the amount of dye fixed at 25, 30 and 35°C has been calculated under the conditions described below and is shown in Table VII. In the same table are the experimental results obtained by dyeing to equilibrium viscose rayon yarn (50 g) in a dyebath (1,500 cc) containing Procion Brilliant Red 2BS or Blue 3GS (0.5 g), sodium carbonate (15 g) and salt (45 g). After dyeing, the fiber

TABLE VII
Comparison of calculated and observed dye fixation from an alkaline dyebath

Dye	Temp (°C)	Dye absorbed	Dye combined	Dye in fiber which is chemically combined (%)	
				Actual	Calculated
Procion Brilliant Red 2BS	25	0.31 g	0.21 g	68	73
	30	0.25 g	0.15 g	60	64
	35	0.24 g	0.15 g	63	65
Procion Blue 3GS	25	0.39 g	0.27 g	69	76
	30	0.36 g	0.25 g	69	73
	35	0.34 g	0.23 g	68	68

was removed, squeezed and weighed to determine the amount of entrained liquor. The concentration of dye in the dyebath was determined optically. The dyed fiber was extracted with boiling Lissapol NC solution (2 g/l) and the amount of dye removed determined optically. In this way the content of fixed and unfixed dye in the fiber was found.

Considering the approximations introduced into the theory, the agreement is good and the theory does explain why a finite equilibrium is reached rather than the complete reaction and 100% fixation which would be expected if no hydrolysis took place.

This theory has an important bearing on practical dyeing. Considering first the effect of temperature, it will be seen from Table VII that, as the temperature is raised, the *total* amount of dye absorbed by the fiber decreases. In other words, the affinity of the reactive and inactive dye decreases with increasing temperature as with all other systems. The percentage of dye absorbed which is *fixed*, however, is only slightly affected by temperature. The reason for this is that, although an increase of temperature increases hydrolysis (Table V), it also increases the rate of diffusion into the fiber (Table VI) and the two effects almost cancel out.

From the practical point of view, therefore, in the two-stage batch dyeing process the temperature of the alkaline phase is relatively uncritical between 20 and 60°C. As noted earlier, however, the exhaustion obtained during the first phase of neutral dyeing decreases considerably with increasing temperature, and when alkali is added, the dye already on the fiber is fixed almost instantaneously and efficiently. Hydrolysis of active dye takes place mainly in the dyebath. Thus the overall process will be most efficient when the maximum amount of dye is induced to go on the fiber in the first neutral-dyeing phase. Consequently in practice the highest degree of fixation will be produced by carrying out the first phase as cold as is conveniently possible, ie, room temperature. There is then no advantage in yield to be obtained by raising the temperature after addition of alkali. It is theoretically possible that an increase of temperature at this point might permit a reduction in the time of dyeing in the second phase, but the success of this maneuver would depend on whether liquor circulation is adequate to give level adsorption of dye at the increased rate of dyeing produced by the higher temperature (since no migration can take place). Success is also likely to depend on the properties of the particular dyes involved and, moreover, the saving in time may be offset by the increased steam usage. These considerations might well repay investigation by dyers under their own conditions, but as a general recommendation the safest policy is to carry out the whole dyeing at or near room temperature.

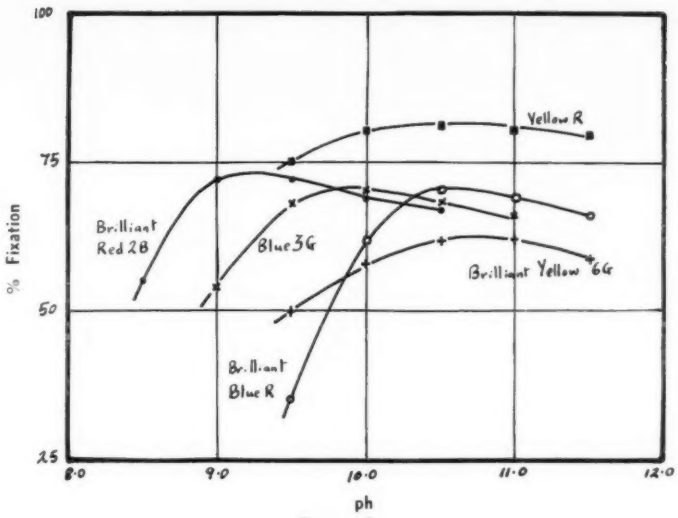


Figure 3

Effect of pH on the fixation of several Procion Dyes

Considering next the effect of alkalinity, at any one temperature, diffusion into the fiber is only slightly affected but the hydrolysis rate is increased with increasing pH. The percentage of dye fixed should, therefore, decrease with increasing pH. Measurements of percentage fixation against pH determined on dyeings carried out by the standard batch dyeing process on viscose rayon and bleached cotton yarns are shown in Tables VIII and IX, and in Figure 3.

It will be seen that in all cases the fixation passes through a maximum. The effect is more noticeable on cotton than on viscose rayon and in all cases the optimum pH of fixation is lower on the latter fiber. The decrease in fixation with increasing pH

TABLE VIII

Fixation of Procion Dyes on viscose rayon at different pH values

(1.5% dye, 30:1 liquor, 50 g/l salt, dyed 30 min without alkali, then 90 min at indicated pH, all at 20°C)

Dye	% Fixation at							
	pH 8.5	pH 9.0	pH 9.5	pH 10.0	pH 10.5	pH 11.0	pH 11.5	pH 12.0
Procion Brilliant Yellow 6G	—	—	50	58	62	62	59	—
Procion Yellow R	—	—	75	80	81	80	80	79
Procion Brilliant Orange G	—	—	68	76	78	78	76	—
Procion Brilliant Red 2B	55	72	72	69	67	—	—	—
Procion Brilliant Blue R	—	—	35	62	70	69	66	—
Procion Blue 3G	—	54	68	70	68	66	—	—

TABLE IX

Fixation of Procion Dyes on bleached cotton at different pH values

(Data as in Table VIII)

Dye	% Fixation at						
	pH 9.0	pH 9.5	pH 10.0	pH 10.5	pH 11.0	pH 11.5	pH 12.0
Procion Brilliant Yellow 6G	—	17	27	34	35	31	—
Procion Yellow R	—	—	65	76	79	75	—
Procion Brilliant Orange G	—	—	61	72	75	72	—
Procion Brilliant Red 2B	35	52	59	58	54	—	—
Procion Brilliant Blue R	—	—	—	55	61	56	48
Procion Blue 3G	—	36	54	63	63	56	—

at the upper end of the range is in accord with the theory outlined above, but the initial increase with increasing pH is not. The explanation of this effect may be found in a more detailed examination of the rate of reaction with the fiber, which has not so far been examined over a range of pH. Clearly, however, the rate of the fixation reaction must be extremely slow in neutral solution, since most of the dye can be washed out of the fiber if no alkali treatment is involved, but on the other hand is very rapid at pH 10 as shown in Table I. Around pH 8, therefore, both the rate of fixation and the rate of hydrolysis must be slow, and in dyeings for a limited time, such as those forming the basis of Tables VIII and IX, it may be that a considerable proportion of the dye still remains in the reactive form at the end of the dyeing operation. As the pH increases, more and more of the dye is either fixed or hydrolyzed, and the optimum pH is the point at which all the reactive dye has been used up in one way or the other at the end of the dyeing period. Further increase of pH then merely accelerates hydrolysis before the dye can get into the fiber. This view is supported by experiments in which the time of dyeing was prolonged up to 6 hours after addition of alkali. The results are shown in Table X and Figure 4.

The results show that, at lower pH, the percentage fixation improves with increasing time of dyeing, but the effect is negligible above pH 10.5. Given infinite time, the fixation would presumably increase continuously with decreasing pH as predicted by theory.

In theory, therefore, the pH of the alkaline stage of batch dyeing should be adjusted according to the dyeing time, the temperature, and the particular dye being used, the alkalinity being such that at the end of the dyeing operation the last part of reactive dye has just been destroyed or has combined with the fiber. The use of strong alkalies giving a much higher pH than the optimum is detrimental in batch dyeing. Again this situation leaves scope for investigation by dyers under their own particular conditions but is unsatisfactory as a general recommendation. Fortunately the change of fixation with increasing pH is not great once the optimum has been passed, while most of the normal Procion dyes show optimum fixation in the same pH range. Consequently, it is possible to arrive at a satisfactory compromise and recommend one general set of conditions for batch dyeing. In the case of viscose rayon, the use of sodium carbonate as the alkali is satisfactory, but on cotton the pH of optimum fixation is higher and a stronger alkali, such as trisodium phosphate, is necessary to obtain maximum yield. Sodium carbonate can be used in cotton dyeing if some loss in yield is accepted. Procion Brilliant Red 2B is somewhat anomalous in that it is more reactive than the other members of the range and can be fixed satisfactorily at a lower pH.

It must be noted that all the work described in the present paper has been concerned with the original highly reactive Procion dyes. A further range of dyes known as the Procion "H" dyes has now been marketed, which are of a similar type but which are less reactive. These "H" dyes have greater stability in aqueous alkaline solution and in alkaline print pastes but in general require heating in order to make them react with cellulose. Consequently, the discussion in this paper cannot be extended to cover the Procion "H" dyes.

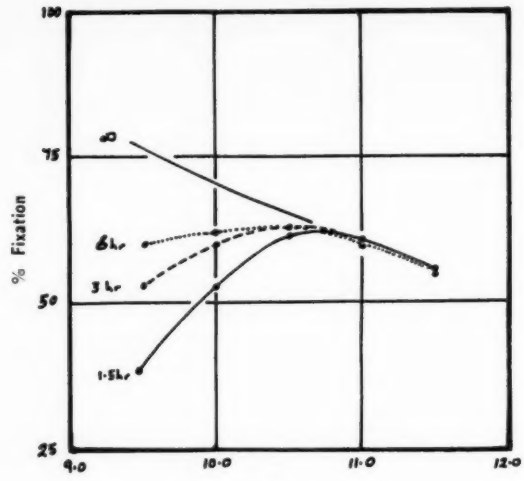


Figure 4

Effect of time on the fixation of Procion Blue 3GS

CONCLUSION

Clearly much remains to be done in this field and the possibilities of further development are great. Although the theory of dyeing with reactive dyes is still in a somewhat elementary state, the basic principles have been uncovered and have resulted in the development of a wide range of novel and practical dyeing methods. Reactive dyes go a long way towards meeting the target of dyes for cellulose which combine simplicity in application with high wetfastness.

ACKNOWLEDGMENT

The author's thanks are due to H H Sumner and A M Wooler for the experimental data included in this paper, and to E Atherton, who developed the modified diffusion theory described herein.

TABLE X

Effect of Prolonging Dyeing Time on the Fixation of Procion Blue 3G at Different pH Values

(Data as in Table VIII)

Time of dyeing after addition of alkali	% Fixation at				
	pH 9.5	pH 10.0	pH 10.5	pH 11.0	pH 11.5
1·5 hours	40	53	62	61	56
3 hours	53	60	63	61	56
6 hours	60	62	62	60	55

LITERATURE CITED

(1) Vickerstaff T, *J Soc Dyers Col* **73**, 257 (1957).

(2) Fowler, JA, and Preston, C, Society of Dyers and Colourists Symposium, Buxton, 1957 (forthcoming publication).

See also pattern cards and technical literature issued by Imperial Chemical Industries Ltd.

A list of papers accepted for future publication in the American Dyestuff Reporter will appear in the February 10th issue.

Proceedings of the

American Association of Textile Chemists and Colorists

Copyright, 1958, American Association of Textile Chemists and Colorists

January 27, 1958

1957 Intersectional Contest 1st-Prize Winner———

RELATION OF THE EFFECT OF RESINS ON LIGHT FADING AND THE TENDERING ACTION OF PHOTOSENSITIVE VAT DYES*

PIEDMONT SECTION

RESEARCH COMMITTEE

L B ARNOLD JR, *chairman & speaker*
Vikon Chemical Co
FRED FORTESS, *vice chairman*
Celanese Corp of America
PAUL B STAM, *secretary*
J P Stevens & Co, Inc
JOANNE SPANGLER, *secretary, Project Committee*
Dan River Mills, Inc
C J DULIN
Arnold Hoffman & Co, Inc
E E EWING
E I duPont de Nemours & Co, Inc
E E HOUSE
North Carolina Finishing Co
R G LAWRENCE
Rohm & Haas Co
L C REYNOLDS
Riegel Textile Corp
H A RUTHERFORD
North Carolina State College
V A SALVIN
Celanese Corp of America
R H SOUTHER
Cone Mills Corp
W P WALKER JR
Cranston Print Works Co

The study of "The Effect of Resin Finishing on the Light Fastness of Vat Dyes", which the Piedmont Section undertook during 1955-6, has been continued. Since publication of the first paper in the November 5, 1956, issue of *American Dyestuff Reporter*, it has been found that there is a correlation between the vat dyes which lose lightfastness after resin treatment and those dyes which show phototendering of cellulose. The same dyes generate peroxide on exposure to light and, where the tests have been made, exhibit both phenomena. The loss in lightfastness after resin treatment has been counteracted for these dyes by addition of an inhibitor to the resin bath.

It has also been found that the fading effect is not limited to resins containing the -NCH_2OH grouping.

Additional vat dyes have been studied and a few more sensitive to fading after resin treatment had been found. Study of additional catalysts and variations in the conditions of the resin treatment show that the effect of the resin on lightfastness is due primarily to the presence of the resin.

INTRODUCTION

HISTORICAL———At the 1956 Intersectional Contest, the Piedmont Section presented a preliminary report on its study of the effect of resins on the lightfastness of vat dyes on cotton fabrics (*1*). Since then the increased importance of resins in wash-and-wear finishes on cotton has demanded a greater understanding of the technology involved.

Because the lightfastness of certain vat dyes is harmed by resin treatment, a full range of shades is not available, and there is need to learn how to overcome this deficiency. This might be done either by synthesizing dyes which are insensitive to the resin or by counteracting the effect of the resins on these dyes. The introduction of new types of resins makes it still more important to determine the fundamentals of their effect on lightfastness.

Our intention is to study the phenomenon further and to find a way of counteracting the effect. Our recent work has brought forth important new developments modifying our concept and extending our information which makes it urgent to report the results to the textile industry at this time.

A number of additional publications on the light-fading phenomenon of dyes have appeared recently. The most important of these is Giles' paper "The Light Fastness of Dyed Fibers—A Statistical Study" (*2*), an extensive study based on lightfastness ratings supplied by dye manufacturers for a large variety of dyes as well as experimental work on the part of the author and his coworkers. In it he attempts to explain a mechanism for light fading. Mention is made that resins have an effect. The literature recognizes anomalies in the behavior of vat dyes under light, such as the tendering of cotton by certain members of the class.

As pointed out in our earlier paper (*1*), this is a complex phenomenon and is continuing to prove still more complex as the experimental work is extended. It is an excellent example of the effectiveness of the scientific method in developing a technology. In our original paper we proposed certain hypotheses to explain the effect of resins on the lightfastness of vat dyes. Then we set about to test them experimentally. On the basis of these experiments we proposed certain additional hypotheses as well as revising our original hypotheses. Again experimental work was outlined to test the new hypotheses.

In this paper we report an important modification in our earlier hypotheses and propose new hypotheses, which will be tested in our future program. The scientific investigations reported in this paper and the preceding paper are good illustrations of the fact that originality in scientific work lies not so much in choice of subject, for the most important problems are evident, but in the ingenuity used in the analysis and in the solution of the problem.

OBJECTIVES———The objectives in this paper have been to review and extend our earlier work to learn more specifically the nature of the

*Presented by L B Arnold, Jr on November 15, 1957 at the 36th National Convention, Hotel Statler, Boston, Mass.

effect of thermosetting resins on the lightfastness of vat dyes. We have also sought to uncover the factors controlling the phenomenon.

In this paper, experiments proposed in our first paper will be reported and the effect of these experiments on our original hypotheses will be discussed. A broader study of the literature has contributed to our understanding of the photochemistry of vat dyes. An attempt will be made to correlate the effect of light on vat dyes after resin treatment with the photodegradation of cotton by certain vat dyes. No account is taken of the change in shade caused by resins on some vat dyes, although it is considerable in some cases.

EXPERIMENTAL BACKGROUND

GENERAL———Although it has been recognized that resins can affect the lightfastness of certain vat dyes, no organized investigation of this problem has been reported. It need not be repeated, as pointed out in our earlier paper (*1*), that the effect of resin finishes on the lightfastness of vat dyes is a problem. It is not as extensive a problem as with other classes of dyes, but is nevertheless serious. In this respect we have discussed in our earlier paper the comments of Smith (*3*) and the work of the Rhode Island Section with direct dyes (*4*) as well as the work of certain dye manufacturers (*5*). In addition there is the recently published work of Giles (*2*).

In our first paper (*1*) we reported that, of a group of thirty widely used vat dyes, fifteen were adversely affected by both dimethylol ethylene urea and an unmethylated melamine resin. Two dyes were improved in lightfastness after the resin treatment. There was no significant difference between these two resins, but dimethylol urea showed considerably less effect than they did and monomethylol urea showed a possible effect on one dye only.

The Fade-Ometer exposures were for a maximum of 60 hours.

On the basis of the experiments performed, and since formaldehyde alone did not reduce lightfastness, the fading effect was attributed to the —NCH_2OH grouping, which appears in all of the resins used. It was found further that the mere presence of the resin caused the effect. Neither catalyst nor curing were required to produce it. Merely drying the resin on the fabric at room temperature was adequate. It was also determined that the effect was not dependent on the catalyst nor due to free formaldehyde even with a catalyst.

Giles (*2*) concluded that, for a given class of dyes of similar properties, the major factors in the control of lightfastness are the particle size of the dye on the fiber and also obstruction to access of air and water to the dye. Obstruction due to its physical position in the structure of the fiber can limit the potential particle size of the dye. He also mentions, in passing, effects from resin finishes and hydrogen bonding agents, such as urea.

However, it has been observed in the dyeing of cellulose acetate fibers with vat dyes where the dye enters the fiber in solid solution, that the lightfastness is very poor in comparison with the same dye on cotton. This is because the dye is present in molecular form in the cellulose acetate while it is in large multimolecular particles on cotton (*6*). On the other hand, where vat pigments in the form of large particles are put into viscose or acetate dope before spinning to produce colored fibers, the lightfastness is excellent. It has been established by tests that the lightfastness of vat dyes on nylon can be increased by soaping, which is simply a matter of increasing particle size.

One possible mechanism for the increased light fading of the sensitive dyes after resin treatment, suggested in our earlier paper (*1*, P822), was the irreversible reduction of the quinoid group in the dye molecules by free radicals. The free radicals would be generated in some measure by the resin under the action of light.

Demonstration of the presence of a free radical mechanism in the heat degradation of thermoplastic fibers has been made in an industrial laboratory (*6*). The effect has been controlled by free radical inhibitors.

Another possible mechanism proposed is a screening effect of incident light to remove its protective elements, which might be caused by the resin treatment. This type of effect is known as radiation antagonism (*7*). It has been demonstrated, both physiologically and otherwise, that if certain elements of the light falling on a body are removed, the remaining elements, usually ultra-violet, can cause more serious degradation of the body than takes place where all of the incident light is allowed to fall on it.

A broadened review of the literature of light fading has revealed a consistency between certain of our earlier results and observations reported on vat dyes which promote the photochemical degradation of cotton. Various observers have noted that certain vat dyes, particularly the yellows, oranges and reds, promote the photochemical degradation of cotton and that fabric dyed with these dyes gives off hydrogen peroxide under the action of light (*8*). We have observed that certain of the dyes that we have found to lose lightfastness after resin treatment are the same as the dyes which, in the absence of resin, promote photochemical degradation and generate hydrogen peroxide under the action of light. We have also found that similar colors that do not show increased fading after resin treatment do not tender under light. The details of the generation of hydrogen peroxide and the tendering of cotton under light by these dyes are sufficiently important so that the phenomenon is discussed in a special section following.

PHOTOCHEMISTRY OF VAT DYES ON COTTON———The tendering of cotton dyed with vat dyes under the action of light has been known for many years. This effect of vat dyes in causing the tendering is confined largely to the yellow, orange, red and a few brown dyes. This is demonstrated in a paper by Fox (*9*). Here he has listed vat dyes which cause photochemical degradation of cotton, illustrating the relative seriousness of the effect.

Scholefield and Goodyear (*8*) demonstrated that hydrogen peroxide is formed when light acts on these particular vat dyes. Their results show that hydrogen peroxide is formed only by a limited group of vat dyes and not by violets, blues and greens. Some of the yellows, for example, do not form hydrogen peroxide and do not tender. The presence of hydrogen peroxide under light exposure was demonstrated by the liberation of iodine from moist starch-iodide paper. Scholefield and Goodyear suggested a correlation between the formation of hydrogen peroxide and the acceleration of the photochemical tendering of cotton dyed with the so-called active vat dyes.

Egerton (*10*) demonstrated that the hydrogen peroxide which is liberated is volatile. His experiments consisted of exposing textile material containing the active dye in the neighborhood of undyed cotton. On exposure to light, the undyed cotton was found to be tendered. This could be explained only by the formation of hydrogen peroxide, which is volatile, since the undyed cotton exposed alone showed no degradation in the presence of light.

Ashton, et al (*11*) have suggested a simple qualitative technique, which is

a modification of the original method of Scholefield and Goodyear for detecting the presence of peroxide in a radiated system containing dyed cotton. It is called, for convenience, the Peroxide Test. It is so arranged that the light passes through a moist test sheet containing starch-iodide onto the dyed fabric. This permits the liberated peroxide to enter the starch-iodide preparation directly. The iodine then discolors the starch, indicating the presence of hydrogen peroxide. A qualitative correlation has been obtained between those dyes which give the greatest formation of iodine stain and those which have the greatest tendering effect.

Ashton et al further show that small quantities of copper will increase the rate of photochemical degradation of undyed cotton. However, the presence of 20 ppm of copper on vat dyed cotton tended to reduce the formation of hydrogen peroxide and thereby improved the resistance to tendering.

A considerable effort has been expended in attempting to understand the mechanism of the formation of hydrogen peroxide in correlating the activity of these sensitive vat dyes with their structure. Extensive work on the tendering of cellulose by these vat dyes has proven the process to be a photosensitized oxidation. The extent of the interest in the problem is shown by the Symposium on Photochemistry in Relation to Textiles held by the Society of Dyers and Colourists in 1949 in which six papers appeared either wholly concerned with or mentioning this problem (*3,9, 10,11,12 & 13*).

In his extensive work, Egerton appears to have demonstrated that the tendering of cellulose in the presence of water takes place by oxidation on the part of some simple intermediate molecule which is produced photochemically. He suggests that the intermediate is hydrogen peroxide, which in turn comes from activation of the dye by light, producing active oxygen which can react with water to form hydrogen peroxide.

Turner and his associates (*14*) have studied the relationship of the redox potential of a group of vat dyes which are specific for photochemical tendering of cellulose. He found that, if the oxidation-reduction titration was carried out in the dark and again, illuminated, the "dark" curve reproduced the "light" curve excepting that the whole "dark" curve was displaced. The degree of displacement can be correlated with the tendering action of the dye. The greater the displacement, the greater is the tendering action of the dye. Caledon Yellow 5G and Cibanone Yellow R have high displacements and are photosensitized, whereas Caledon Blue R has no displacement and does not form hydrogen peroxide.

TABLE I
Vat dyes evaluated

Coded	Dyes	Old Colour Index or Prototype No.	New Colour Index No.	Effect of Resin*
	*Anthraquinone Vat Yellow (Flavone) GC	Pr 9	67300/1	O**
	*Anthraquinone Vat Yellow 3R	Pr 452	70805	–
1	Anthraquinone Vat Yellow 5GLL	– – –	– – –	– – –
2	Anthraquinone Vat Fast Yellow Paste	– – –	– – –	– – –
3	Anthraquinone Vat Golden Orange RRT	CI 1098	59705/6	+
4	Anthraquinone Vat Brilliant Orange RK	Pr 116	59300/1	O
5	Anthraquinone Vat Golden Orange 3G	Pr 290	69025	– –
6	Anthraquinone Vat Red FG	– – –	– – –	–
7	Anthraquinone Vat Red FBB	Pr 296	67000/1	– – –
8	Anthraquinone Vat Scarlet R	Pr 449	71140	+
9	Thioindigoid Vat Pink FF	Pr 109	73360/1	O
10	Anthraquinone Vat Brown R	CI 1151	69015/16	–
	*Anthraquinone Vat Brown VR	– – –	– – –	–
	*Anthraquinone Vat Brown BR	Pr 118	70800/1	–
	*Anthraquinone Vat Rubine R	Pr 124	70320	O
11	Anthraquinone Vat Red Brown 5RF	Pr 448	69020	–
12	Anthraquinone Vat Blue BCS	CI 1113	69825/6	O
13	Anthraquinone Vat Blue GCD	CI 1112	69810	O
14	Thioindigoid Vat Blue GR (Hydron Blue R)	CI 969	53630	O
	*Anthraquinone Vat Dark Blue BR (BO)	CI 1099	59800	O
	*Anthraquinone Vat Navy Blue RA	CI 1100	59815	+
15	Anthraquinone Vat Navy Blue B	– – –	– – –	O
	*Anthraquinone Vat Brilliant Violet 3B	Pr 288	60005	O
	*Anthraquinone Vat Brilliant Violet 4R	CI 1104	60010/11	–
	*Anthraquinone Vat Violet VN (FFB)	CI 1163	68700	–
	*Anthraquinone Vat Violet RK (AR)	CI 1135	63365	–
16	Anthraquinone Vat Khaki 2G	Pr 122	71050	O
17	Anthraquinone Vat Jade Green (Supra type)	CI 1011	– – –	–
18	Anthraquinone Vat Olive Green B	Pr 293	69500/1	O
19	Anthraquinone Vat Olive R	CI 1150	69005	–
20	Anthraquinone Vat Olive T	Pr 547	69525/6	O
21	Anthraquinone Vat Gray R	– – –	– – –	O
22	Anthraquinone Vat Gray 2G	– – –	– – –	O
23	Anthraquinone Vat Direct Black 3G	– – –	– – –	O
24	Anthraquinone Vat Direct Black RB	Pr 289	65230	–
	*Anthraquinone Vat Black B (Chlorinated type)	CI 1102	59850	O

*Dyes not run the second time.
**Brief recheck indicates slight sensitivity.

Legend:
O No effect
+ Improvement
– Slight loss
– – Appreciable loss
– – – Bad loss

TABLE II
Dyes used in resin process study

Coded	Dyes	Old Colour Index or Prototype No.	New Colour Index No.	Effect of Resin*
1	Anthraquinone Vat Yellow 5GLL	– – –	– – –	– – –
2	Anthraquinone Vat Fast Yellow Paste	– – –	– – –	– – –
3	Anthraquinone Golden Orange RRT	CI 1098	59705/6	+
4	Anthraquinone Vat Brilliant Orange RK	Pr 116	59300/1	O
5	Anthraquinone Vat Golden Orange 3G	Pr 290	69025	– –
7	Anthraquinone Vat Red FBB	Pr 296	67000/1	– – –
8	Anthraquinone Vat Scarlet R	Pr 449	71140	+
9	Thioindigoid Vat Pink FF	Pr 109	73360/1	O
10	Anthraquinone Vat Brown R	CI 1151	69015/6	–
21	Anthraquinone Vat Gray R	– – –	– – –	O
22	Anthraquinone Vat Gray 2G	– – –	– – –	+

*Legend:
O No effect
+ Improvement
– Slight loss
– – Appreciable loss
– – – Bad loss

EXPERIMENTAL PROGRAM

Our first objective has been to review the critical aspects of our original work and to extend it to provide a better basis in terms of a broader range of affected and unaffected dyes. This gives us a new and sounder basis for testing our hypotheses. To this end we have studied the effect of the resins on a number of new dyes of variant chemical nature as well as extended our work on eighteen of the first set of dyes. A major portion of this was done with fresh dyeings. Table I lists the twenty-four dyes. In this case the dyeings were all made in a light shade (0.25%). This was done with dimethylol ethylene urea and methylated trimethylol melamine under a variety of experimental conditions, as shown in Table III. The experimental details are given in a subsequent section, Experimental Procedure.

A new test group was then selected consisting of eleven dyes, some sensitive and some insensitive to resin finishing. These are listed in Table II.

This group was used for running various experiments used to test the hypotheses proposed.

From among the experiments proposed in our first paper (*1*) and suggested by our literature study we selected the following aspects of the problem for further study:

I) Effect of resins containing no methylol attached to nitrogen.

II) Determination of the photochemical generation of hydrogen peroxide in the sensitive dyes.

III) Effect of an inhibitor on light fading after resin treatment.

IV) Effect of a nonchloride catalyst.

V) Effect of formaldehyde with hydroxyethyl cellulose as a fixative to counteract evaporation.

VI) Effect of resins on mixtures of dyes which include dyes already studied individually.

VII) Effect of curing temperature and washing on dyed fabrics without resin treatment.

VIII) Review of the effect of the resin concentration on the fading effect and the effect of applying additional resin over resin already applied.

IX) Effect of a variety of resin treatments and subsequent processing on the undyed bleached fabric.

The effect on non-nitrogen-containing resins was studied, using an acetone-formaldehyde-starch resin, an acrolein-formaldehyde resin, and an epoxy resin. Two new products with methylol groups on nitrogen were included in this experiment. They were type 8 nylon applied from 20% methanol and monomethylol dimethyl hydantoin.

In order to get at the mechanism of the reaction in some measure, the effect of a peroxide oxidation inhibitor was studied by dispersing diallyl phthalate in the resin bath with a suitable dispersing agent. It, incidentally, is also a free radical inhibitor.

Giles (*2*) states that destruction of dyes by light fading on cotton is an oxidation process; inhibitors might control it. It is also possible that, in the case of a dye which generates hydrogen peroxide photochemically, the hydrogen peroxide could liberate free radicals from the resins, which might in turn react with the quinoid structure of the dye in the manner described by Szwarc (*15*). An inhibitor such as diallyl phthalate could just as well capture free radicals and stop the light fading. Experiments to determine whether peroxide is generated were also run, exposing fabric dyed with a resin-sensitive dye in the presence of starch-iodide paper.

Zinc nitrate, which is the only commonly used nonchloride catalyst, was studied under a number of conditions. The effect of formaldehyde with a fixative was studied, using formalin in the presence of hydroxy ethyl cellulose.

Experiments on a few dyes were added to determine how low a concentration of resin would affect the lightfastness of sensitive dyes. Experiments were also included that called for applying ethylene urea and melamine as such, ie, not reacted with formaldehyde.

It is important, from plant experience and from the work of earlier observers, to study the effect of resin finishes on compound shades, ie, shades made up of more than one dye, including one or more dyes already studied individually. It has been reported that, in some cases, a dye which is bad individually is improved in lightfastness in combination with other dyes and vice versa (*3*).

The effect of curing and washing on dyed fabrics without resin treatment is important, as the high heat treatment could affect some dyes adversely. It has been included in this set of experiments. Also, undyed bleached fabric was treated with a variety of resin treatments to determine whether there was any discoloration, which could affect the shade or apparent fading. This experiment is straightforward and is in the tables reporting the results.

The experiments on the effect of resin concentration on the fading effect and the effect on double application of resin treatment were run. Experiments to review monomethylol urea, to extend the concentration and the conditions, and to use it without catalyst and without curing as well as with catalyst and curing, were also run.

A number of experiments were proposed in our earlier paper (*1*), but we have not yet completed these in the course of carrying out our program. One is to study the possible screening effect of resins on incident light to remove protective rays. The protective effect of certain radiations, known as radiation antagonism, was discussed in the earlier paper (*1*, P822).

On the basis of extensive plant experience, it was decided that it is not worthwhile making experiments to determine whether the final pH, or alkalinity, of fabric makes a difference in fading.

Although we have not considered it justified to study the effect of the method of dyeing on the lightfastness after resin treatment, it is possible that, where a large particle size is produced, the fading would be reduced as against our present method of pigment padding. However, from a practical standpoint, it does not seem that this is going to give a significant difference nor is it going to affect the mechanism by which fading induced by the resin is brought about. Also, it is dubious that the effect of the resin itself is to reduce the particle size of the dye, because stripping the resin restores the lightfastness to normal in the case of the sensitive dyes.

EXPERIMENTAL PROCEDURE

DYEING PROCEDURE —— Dyeings were made with the twenty-four dyes listed in Table I. Dyeings were made at 0.25% by the pigment-pad - dry - chemical - pad - steam method of dyeing. The dyeings were made on an 80 x 80 print cloth, which had been prepared for dyeing in a print works. Four pieces of cloth each eight inches wide and two yards long were passed through each dye solution to provide a sufficient supply of cloth. The dyed fabric was then dried by being suspended horizontally in the air at room temperature. The pieces were then developed by padding through a solution containing four oz/gal of caustic soda and of hydrosulfite. They were then immediately steamed for 30 seconds at 218°-220°F. They were rinsed in cold water and then oxidized for 10 minutes at 130°F in a bath containing two g/l of sodium perborate. Finally, the pieces were soaped for ten minutes at the boil in a bath containing one g/l of synthetic detergent and 1.5 g/l of tetrasodium pyrophosphate. They were rinsed subsequently in hot water, then cold, and soured in 0.5% acetic acid. They were ironed dry without rinsing.

The group of eleven dyes in Table II was selected to represent dyes improved, dyes unaffected and dyes harmed in lightfastness by the resin. In some of the experiments on the various aspects of resin treatment, either because of shortage of dyed fabric or shortage of time, fewer than the eleven dyes were used.

RESIN TREATMENT —— The melamine resin used in the work was a commercial methylated trimethylol melamine formaldehyde. The dimethylol ethylene urea resin was specially prepared from recrystallized ethylene urea. The concentrations of resin, catalyst, curing

temperature and time and other details of the experiments are cited in each of the tables. All fabric was soured in one percent acetic acid and air dried before padding with resin to be certain that it was free of alkali. The resin application was carried out by sewing together eight ½-inch lengths of each dyed sample and then padding through the resin solution followed by a squeeze roll. Drying and curing were carried out in a continuous laboratory set-up, which is used regularly for this purpose. In general, drying was at room temperature and curing for 70 seconds. The temperatures are shown in the tables. Where washing was done after curing, it was with 0.5% nonionic detergent in water at pH 8.5—9.0 at 120°F for ten minutes followed by a thorough rinsing.

TESTS FOR LIGHTFASTNESS——Following the resin treatments, which were all carried out in one laboratory, duplicates were mounted for lightfastness tests by the conventional procedure and were forwarded to a number of laboratories for exposure in the Fade-Ometer. The tests were so arranged that the duplicates were in different machines. In the complete set of the twenty-four dyes, exposure was for 20, 60 and 120 standard Fade-Ometer hours, as determined by the National Bureau of Standards calibration paper. During exposure, Sections B and C of the shields were not removed during the test. Section A was exposed for 20 hours, the center section for 60 hours and Section D for 120 hours.

In subsequent tests, exposure was made in some cases for short periods of time only where it was already known that the dye would or would not show an effect at this time in order to determine the effect of a variation in the procedure.

EVALUATION OF FADING——Evaluation was conducted in all cases by one or more individuals whose daily work is the evaluation of dyeings. No consideration was given to shade change. The evaluation was made for fading only. Many of the dyes show a pronounced change in shade after resin treatment but no increase in fading against the same dyeing without resin treatment. Others, whose lightfastness is sensitive to resin treatment, may show very little shade change.

The scale of evaluation used roughly approximates the International Gray Scale. Our scale is rated as follows:

5—No change
4—Noticeable change
3—Appreciable change
2—Considerable change
1—Very great change.

Results for all the lightfastness evaluations made on tests run are shown in the various tables in general with the padding formulas used on the fabric.

The tests run are described in general in the previous section on Experimental Program.

In the case of the epoxy resin, it was emulsified with polyvinyl alcohol (following the instructions of the manufacturer) and applied with a zinc fluoborate catalyst.

Both the acetone-formaldehyde-starch and the acrolein-formaldehyde resins were applied with amine hydrochloride catalyst.

In experiments in which crystalline ethylene urea and melamine were applied, the crystalline ethylene urea was dissolved in water and padded at room temperature. The melamine was dissolved in water as a saturated solution at 100°C and padded.

PEROXIDE EXPERIMENT——The experiment to determine whether the generation of peroxide could be reproduced with our dyeings was carried out on two dyes whose lightfastness had been found sensitive to resin treatment. These were Anthraquinone Vat Yellow 5GLL and Anthraquinone Vat Golden Orange 3G.

The experiment was carried out by exposing several glass sandwiches in the Fade-Ometer for two hours. The sandwiches were made up with a layer of dyed cloth on which was laid a small strip of moist starch-iodide paper, so that the fabric was exposed on each side of it. Another piece of moist starch-iodide paper was placed beneath the fabric and then the bottom plate of glass was pressed against the sandwich. The sandwich was then sealed with tape all around the edges. The water used in moistening the starch-iodide paper had been brought to pH 5.5 with acetic acid. In one sandwich was undyed cotton cloth, in another was the dyed fabric without resin, in a third was the dyed fabric resin-treated, in a fourth was moist starch-iodide paper with no fabric, and in a fifth was resin and dye dried on glass with no cloth but with starch-iodide paper. The iodine turned color only in the case of the dyed fabric without resin and the same with resin. In the other cases there was no discoloration. It is important to note that, if the exposure is carried out much more than two hours, the iodine, where it forms, will be bleached out by the light.

INHIBITOR EXPERIMENT——The inhibitor experiments were carried out by padding a 10% solution of diallyl phthalate along with 10% of the methylated trimethylol melamine resin. The reason the high concentration was used is that the diallyl phthalate is volatile and vaporizes off to some extent during curing. There was no benefit found from it at 2% padded along with dimethylol ethylene urea or with the melamine resin. It has not been run as yet at 10% with dimethyl ethylene urea resin.

EXPERIMENTAL RESULTS

NEW DYES AND GENERAL EXPERIMENTS——A review of the dyes studied previously showed essentially no change in their ratings with respect to fading after resin treatment. Of the six new dyes studied, one showed severe fading and two showed light fading. One showed possible improvement and two were unaffected. These results are shown in Table I in which the dyes are listed. It will be noted that a new dye affected was Anthraquinone Vat Fast Yellow Paste. The bargraph in Figure 1 shows graphically the effect of the resins on some of the most sensitive dyes with two which are unaffected. Details of the light-fading tests on the twenty-four dyes are in Table III. This emphasizes the relative sensitivity of vat yellows to light fading after resin treatment, and the consequent need for a vat yellow which is insensitive to the effect of resins in its lightfastness.

In order to be certain that we had the optimum particle size in our dyeings, they were well soaped in all cases. This should eliminate the possibility that any of the fading effect observed was due to change in particle size, although it is possible that the heat treatment in curing reduced the dye aggregrates and thereby lowered their lightfastness. In some cases the control, cured and washed without resin, showed more fading than the unprocessed dyeings (see Table III).

The new colors which were affected only slightly were Red Brown 5RF and Red FG. Scarlet R seemed to be improved slightly at the longer fading time. Navy Blue B and Blue GCD were unaffected. The resistance of some of the reds and the blues and violets to the effect of resin is important as this is also true of the light

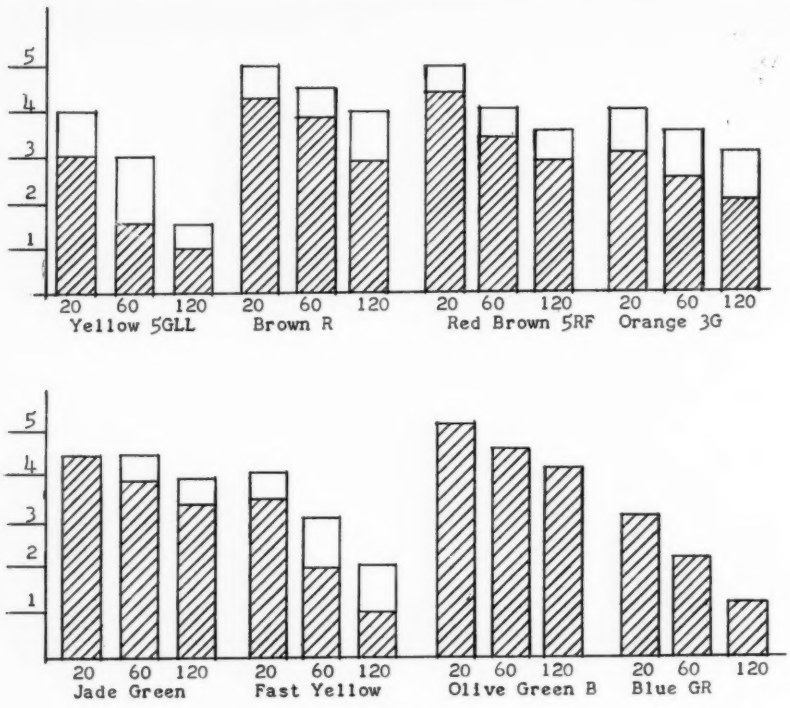


Figure 1

Effect of resins on selected dyes

Fastness rating without resin—no cross-hatching
Fastness rating with resin—cross-hatching

degradation effect on cotton (see above).

One anomaly appearing in the first set of tests, which was not discussed in the first paper but which has appeared again, is the inconsistency of Red FBB in the effect of resin on its lightfastness. In some tests it shows severe fading after resin treatment. In other tests on the same dyeing but with a fresh resin treatment only very slight fading takes place. We have no explanation for this at this time. Fox (9) also noted its activity in promoting photodegradation of cotton.

A most important development in our recent work has been the observation that resins which do not contain nitrogen can cause a pronounced increase in light fading of the sensitive vat dyes. An interesting effect also is that the nonnitrogenous resins do not have the same relative fading effect on the different vat dyes among themselves or compared with the nitrogen-containing resins. The results of this test are shown in Table IV. At the time it was run, only a limited number of dyed fabrics were available from our earlier work so that not all of the dyes previously studied in the first paper could be included.

The acrolein formaldehyde resin (X2S type) caused a slight increase in fading with curing, but without curing, it caused a severe increase in fading of Yellow 5GLL. It also caused increased fading on Brown R with or without curing. This is a dye which shows only slight increase in fading with the nitrogen-type resin. Pink FF is affected adversely, as also is Orange 3G and Red FBB by this resin.

The epoxy resin shows an increased resistance to fading on Pink FF and no effect on Red FBB although possible increased resistance to fading without curing. It shows increased fading with Orange 3G and a pronounced increase in fading on Yellow 5GLL and Brown R.

The acetone-formaldehyde-starch resin shows no pronounced effect on Yellow 5GLL but it does show a pronounced effect on Red FBB, a slight effect on Brown R and Orange 3G as well as a pronounced effect on Pink FF. Another nitrogen-containing resin included in this test, monomethylol dimethyl hydantoin, showed only a very slight effect on Yellow 5GLL, Brown R and Red FBB but a pronounced effect on Orange 3G and an increased resistance to fading on

TABLE III

Fading of the twenty-four dyes

Coded	Dyes	Hours of Exposure	Control	Blank	A	B
1	Yellow 5GLL	20	4	4	3	4 3
		60	3	3	2/1	2
		120	2/1	2/1	1	1
2	Fast Yellow	20	4	4	3	3
		60	3	3	2	2
		120	2	2	1	1
3	Orange RRT	20	4 3	4 3	4 3	4 3
		60	3	3	3	3
		120	2	2	2	2
4	Brilliant Orange RK	20	5 4	5 4	5 4	5 4
		60	4	4	4	4
		120	3	4 3	3	3
5	Golden Orange 3G	20	4	4	3	3
		60	4 3	4 3	3 2	3 2
		120	3	3	2	2
6	Red FG	20	4		4 3	4 3
		60	3		3 2	3
		120	2		2	2
7	Red FBB	20	4 3	4 3	3 2	3 2
		60	3	3	2	2
		120	2	2	2/1	2/1
8	Scarlet R	20	5 4	5 4	5 4	5 4
		60	4 3	4	4	5 4
		120	3	3	4 3	4
9	Pink FF	20	3	3	3	3
		60	1	2	1	1
		120	1	1	1	1
10	Brown R	20	5	5	5 4	5 4
		60	5 4	5 4	4	4
		120	4	4	3	3
11	Red Brown 5RF	20	5 4		4	4
		60	4		4 3	4 3
		120	4 3		3	3
12	Blue BCS	20	5		5	5
		60	5 4		5 4	5 4
		120	4		4	4
13	Blue GDC	20	5		5	5
		60	5 4		5 4	5 4
		120	4		4	4
14	Blue GR	20	3		3	3
		60	2		2	2
		120	1		1	1
15	Navy Blue B	20	4 3		4 3	4 3
		60	3 2		3 2	3 2
		120	2 1		2 1	2 1
16	Khaki 2G	20	5		5	5
		60	5 4		5 4	5 4
		120	4		4	4
17	Jade Green	20	5 4		5 4	5 4
		60	5 4		4	4
		120	4		4 3	4 3
18	Olive Green B	20	5		5	5
		60	5 4		5 4	5 4
		120	4		4	4
19	Olive R	20	5 4		4	4
		60	5 4		4	4
		120	4		4 3	4 3
20	Olive T	20	5		5	5
		60	5 4		5 4	5 4
		120	4		4	4
21	Gray R	20	5	5	5	5
		60	5	5	5 4	5 4
		120	4	5 4	4	4
22	Gray 2G	20	5 4	5 4	5 4	5 4
		60	4	4	4	4
		120	4 3	4 3	4 3	4 3
23	Direct Black 3G	20	5 4		5 4	5 4
		60	4		4 3	4 3
		120	4 3		3	3
24	Direct Black RB	20	4		4 3	4 3
		60	2		2	2
		120	1		1	1

A—10% dimethylol ethylene urea (50%), 1% amine hydrochloride catalyst, air dried, cured 70 seconds @ 160° C, washed.
B—7.5% methylated trimethylol melamine (80%), 1% amine hydrochloride catalyst, air dried, cured 70 seconds @ 160°C, washed.

TABLE IV

Fading effect of new resins

Coded	Dyes	Hours of exposure	Control	New resins A NC*	A C**	B NC*	B C**	C NC*	C C**	D NC*	D C**	E NC*	E C**	F C***	F C****
		20	4	4	4	3	4	4/3	4/3	4	4	4	4	4	4
1	Yellow 5GLL	40	4/3	3	4/3	3/2	3	3/2	3/2	3	4/3	3	3	4/3	4/3
		60	3	3/2	3	2	3/2	2	2	3/2	3	3/2	3/2	3	3
		20	5/4	4/3	4	3	3	4	4	5/4	5/4	3	3	5/4	5/4
5	Golden Orange 3G	40	4	3	4/3	3/2	3/2	4/3	4/3	4	4	3/2	3/2	4	4
		60	4/3	3/2	3	2	2	3	3	4/3	4/3	2	2	4/3	4/3
		20	4/3	3/2	3/2	3/2	2	4	4/3	4	4	4	4	4/3	4/3
7	Red FBB	40	3	2	2	2	1	4/3	3	4/3	4/3	4/3	4/3	3	3
		60	3/2	1	1	1	1	3	3/2	3	3	3	3	3/2	3/2
		20	3	2	2	3/2	3/2	4/3	4/3	4/3	4/3	4/3	4/3	3	3
9	Pink FF	40	2	1	1	2/1	1	3	3	3	3	3	3	2	2
		60	1	1	1	1	1	3/2	3/2	3/2	3/2	3/2	3/2	1	1
		20	5	5/4	5/4	4	4	4	4	5	5	5/4	5/4	5	5
10	Brown R	40	5/4	4	4	4/3	4/3	4/3	4/3	5/4	5/4	4	4	5/4	5/4
		60	5/4	4	4	3	3	3	3	5/4	5/4	4	4	5/4	5/4

*No cure.
**Cured 70 seconds @ 180°C
***160° cure.
****160° cure, catalyst omitted.
A—acetone-formaldehyde-starch "545" resin (52%).
B—acrolein-formaldehyde "X-2-S" resin (55%).
C—epoxy resin (emulsified with Elvanol); zinc fluoborate catalyst.
D—type-8 nylon (20%).
E—monomethylol dimethyl hydantoin (100%).
F—formaldehyde (10%) + 5% hydroxy ethyl cellulose; 1% zinc nitrate catalyst.

Pink FF. The type-8 nylon showed a very slight increase to fading on Red FBB but none on Orange 3G, Brown R or Yellow 5GLL and showed a slight increase in resistance to fading with Pink FF. In some cases the shade changes with these resins may be due to secondary effects, such as the yellowing of the resin itself with acetone formaldehyde.

Another interesting finding which came out of this work was that formaldehyde applied in the presence of hydroxy ethyl cellulose and a catalyst, which definitely fixes the formaldehyde in the fiber, had no effect on lightfastness on any of the dyes. The results were the same, using formaldehyde alone and with a catalyst, as reported in our earlier paper (*1*). The formaldehyde-hydroxyethyl-cellulose-finished cotton was insoluble in standard copper amine complex, indicating cross-linking and therefore reaction of the formaldehyde with the cotton.

The absence of influence on the part of the catalyst is further emphasized in Table V. Here it can be seen that zinc nitrate, in common with other catalysts, does not affect fading. In fact, it appears in some cases that fading is less where zinc nitrate is used than where the amine hydrochloride catalyst or no catalyst is used. This means perhaps, that it reduced the effect of the resin. Another observation is that the methylated trimethylol melamine resin had less effect than the dimethylol ethylene urea resin where there was any difference. In the earlier tests, the unmethylated melamine resin showed no significant difference from the dimethylol ethylene urea resin. Because of lack of time, it was not possible to run tests making a direct comparison between the unmethylated melamine and the methylated trimethylol melamine resin.

TABLE V

Coded	Dyes	Hours of Exposure	Control	A	B	C	D	E	F	G	H
	Blank	40	5	5	5	5	5	5	5	5	5
		60	5	5	5	5	5	5	5	5	5
		120	5	5	5	5	5	5	5	5	5
1	Yellow 5GLL	40	4	3	3	3	3	4/3	4/3	4/3	4/3
		60	3	2/1	2/1	2/1	2/1	2	2	2	2
		120	2/1	1	1	1	1	1	1	1	1
2	Fast Yellow	40	4	3	3	3	3	4/3	4/3	4/3	4/3
		60	3	2	2	2	2	3/2	3/2	3/2	3/2
		12	2	1	1	1	1	2/1	2/1	2/1	2/1
3	Orange RRT	40	4/3	4	4	4	4/3	4	4	4	4/3
		60	3	4/3	4/3	4/3	3	4/3	4/3	4/3	3
		120	2	3/2	3/2	3/2	2	3/2	3/2	3/2	2
4	Brilliant Orange RK	40	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4
		60	4	4	4	4	4	4	4	4	4
		120	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3
5	Golden Orange 3G	40	4	3	3	3	3	3	3	3	3
		60	4/3	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2
		120	3	2	2	2	2	2	2	2	2
8	Scarlet R	40	4	5/4	5/4	5/4	4	5/4	5/4	5/4	5/4
		60	4/3	4	4	4	4/3	4	4	4	4
		120	3	3	3	3	3	3	3	3	3
9	Pink FF	40	3	3	3	3	3/2	3	3	3	3
		60	2/1	2	2	2	2/1	2	2	2	2
		120	1	1	1	1	1	1	1	1	1
10	Brown R	40	5	4	4	4	5/4	5/4	5/4	5/4	5/4
		60	5/4	4/3	4/3	4/3	4	4	4	4	4
		120	4	3	3	3	4/3	4/3	4/3	4/3	4/3
7	Red FBB	40	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3
		60	3	3	3	3	3	3	3	3	3
		120	2	2	2	2	2	2	2	2	2
21	Gray R	40	5	5	5	5	5	5	5	5	5
		60	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4
		120	4	4	4	4	4	4	5/4	4	4
22	Gray 2G	40	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4
		60	4	4	4	4	4	4	4	4	4
		120	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3	4/3

A—20% dimethylol ethylene urea (50%), 1% amine hydrochloride catalyst, air dried, cured 70 sec @ 160°C, washed.
B—20% dimethylol ethylene urea (50%), 1% zinc nitrate catalyst, air dried, cured 70 sec @ 160°C, washed.
C—10% dimethylol ethylene urea (50%), 1% amine hydrochloride catalyst, air dried, cured 70 sec @ 160°C, washed, repadded.
D—20% dimethylol ethylene urea (50%), no catalyst, air dried, cured 70 sec @ 160°C, washed.
E—15% methylated trimethylol melamine (80%), 1% amine hydrochloride catalyst, air dried, cured 70 sec @ 160°C, washed.
F—15% methylated trimethylol melamine (80%), 1% zinc nitrate catalyst, air dried, cured 70 sec @ 160°C, washed.
G—7.5% methylated trimethylol melamine (80%), 1% amine hydrochloride catalyst, dried, cured and washed as above, repadded.
H—15% methylated trimethylol melamine (80%), no catalyst, air dried, cured 70 sec @ 160° C, washed.

An increase in the maximum fading time in the tests from 60 to 120 hours only produced a higher degree of fading with about the same relative effect for sensitive and insensitive dyes (see Table III). There were no cases where, betwen 60 and 120 hours, the resin treatment caused a sensitive dye to fade out much more rapidly than it faded without the resin treatment. This means that the fading effect in the presence of the resin is at about the same relative rate as without the resin. Apparently the major effect of the resin takes place in the first few hours of fading.

It was also observed in these tests that an increase in the concentration of the resin does not increase the rate of fading. There was no difference whether the increase in resin concentration was obtained by padding more resin in the same bath or by padding additional resin on top of the fabric already treated with the resin. This suggests that there is a limiting concentration above which there is no increase in effect from a particular resin.

Experiments at lower concentrations of the dimethylol-ethylene urea resin show that there still is some effect. This was done on three dyes only. The effect was about ½ grade unit with both 1% and 5% of the dimethyl-ethylene urea resin on Orange 3G, which with 10% fades substantially more. On the other hand, the effect on Fast Yellow was as bad at 1% of the resin as at 10%. On the Red FBB the effect was negligible at 1% but pronounced at 5% of the resin. In this test all exposures were for 20 hours only. The results are shown in Table VI.

Our repeat tests in Table V confirm our earlier observation that neither catalyst nor curing are necessary to obtain the fading effect where it occurs. The mere presence of the resin dried at room temperature will accomplish it. Curing does in some cases appear to intensify the effect.

Tests were also run to determine the effect of curing temperature on the light fading of the test list of dyes without resin. The blank (at the top of Table III) was put through curing and washing without resin treatment. Some dyes show slightly increased light fading after this treatment. The possible discoloration caused by certain of the resin treatments was checked by padding a piece of bleached white cloth through them. As can be seen from Table V, there is no evidence of color or change. All were alike.

The evaluation of monomethylol urea was carried further with paddings on all twenty-four dyes at 10% and 20% (43% solids) with catalyst and curing, and without catalyst or curing. It was also run with zinc nitrate catalyst and cured, and also with no catalyst and cured. No significant effect on lightfastness was observed (Table IV).

To determine more closely the active agent in the resin, experiments were run applying 5% of ethylene urea from water and 3% of melamine (saturated solution in water at 100°C). Neither compound had been reacted with formaldehyde at all. The treated fabrics were air dried and then light exposed. The paddings were made on our test group of eleven dyes (Table II) with the exception of Gray R, which was omitted because of lack of dyed fabric. In all cases where the dye loses lightfastness as a result of resin treatment, the ethylene urea caused a pronounced loss in lightfastness, whereas the melamine caused no loss or less loss than the ethylene urea (Table VI). The answer apparently is that melamine, which is a very stable molecule, contains no groupings that can produce free radicals whereas the ethylene bridge in the ethylene urea is relatively unstable and could generate free radicals.

In order to determine whether hydrogen peroxide is being generated, as reported earlier, (*8*), experiments were run with starch-iodide paper in contact with the resin-treated fabric dyed with a sensitive or active dye. Two dyes were used, Yellow 5GLL and Golden Orange 3G. The latter has been reported as to be a peroxide generator (*8*), but Yellow 5GLL has not been reported as one, probably because it is a recently developed dye. Evidence of peroxide was positive for all three dyes, both with and without resin treatment, as the starch-iodide paper was discolored. Positive results were obtained for peroxide also with the same dyeings without resin treatment. This is a definite correlation with the tendering action under light shown by the same or similar dyes. It means that peroxide generation is not interfered with by the presence of the resin.

CORRELATION OF THE TENDERING ACTION OF DYES WITH THE RESIN EFFECT ON LIGHTFASTNESS——The group of vat dyes for which lightfastness in the presence of resin has been determined has been extended to practically the entire group of the more representative vat dyes. An excellent positive correlation exists between those dyes which showed tendering activity on cotton and those whose lightfastness is clearly reduced by resin application. Specific examples are Orange RRT and Golden Orange 3G. Although the Orange RRT has basically poor lightfastness, it is unaffected by the addition of resin. It is clearly one of the structures which does not tender. The Golden Orange 3G shows both tendering action and reduction of lightfastness because of resin. A similar property is shown for the Vat Red FBB.

On the other hand, a large number of greens, yellows and blues showed neither tendering effect nor reduction in lightfastness from resin. The same is true of some reds, such as Scarlet R.

The correlation of dye structure with tendering action has received considerable attention, as mentioned previously. Landolt (*13*) and Fox (*9*) have made correlations independently between the structure of vat dyes and their tendering properties on cellulose when exposed to light. Fox has arranged thirty-four yellow and orange vat dyes in their order of tendering activity. The dyes examined were of widely different structure and it was definitely established that the commercial vat dyes from the anthraquinone thiazol, diphthaloyl stilbene and anthraquinone-thioxanthene groups represent the worst types of vats in their tendering activity. Other active dyes come from the commercial anthraquinonyl amino-triazines and pyranthrone groups. Dyes from the commercial flavanthrone or anthraquinone-acridone groups are essentially nontendering. Two basic structures are shown in Figure 2.

TABLE VI

Coded	Dyes	Hours of Exposure	Control	A	B	C	D
1	Yellow 5GLL	20	4			4/3	3
2	Fast Yellow	20	5/4	4/3	4/3	3/2	5/4
3	Golden Orange RRT	20	3			4/3	4/3
4	Brilliant Orange RK	20	4			4	4
5	Golden Orange 3G	20	4	4/3	4/3	3/2	4/3
7	Red FBB	20	4	4	3	3/2	4
8	Scarlet R	20	4			4/3	4
9	Pink FF	20	3/2			2	2
10	Brown R	20	5/4			3	5/4
19	Olive R	20	5/4			5/4	5/4

A—1% dimethylol ethylene urea (50%), 1% zinc nitrate catalyst, cured @ 160°C.
B—5% dimethylol ethylene urea (50%), 1% zinc nitrate catalyst, cured @ 160°C.
C—5% crystalline ethylene urea, air dried, no cure.
D—3% melamine (saturated solution in water @ 100°C), air dried, no cure.

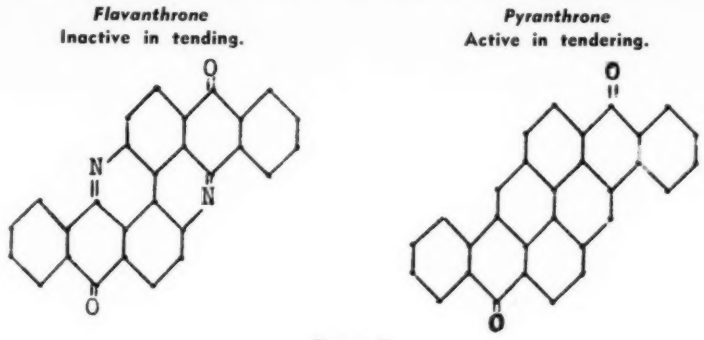


Figure 2

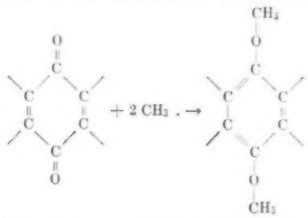
The only difference in the constitution of the two types shown in Figure 2 is that the benzene rings of the pyranthrone are replaced by fused pyridine rings in the flavone. It is to be noted that two yellows, Indanthrene Yellow 4GK and 7GK, contain pyridine rings and are nontendering in accordance with the above function of the pyridine groups in stabilizing the molecule. However, the general correlation is good as dyes whose lightfastness is badly affected by resins are relatively active in tendering under light. Also, dyes whose lightfastness is only slightly reduced by resins are inactive or only slightly active in tendering. This suggests strongly a correlation between the tendering effect and the effect of resins on lightfastness.

In Table VII we have listed dyes, reported by Fox as causing degradation, which have prototypes evaluated by us for sensitivity to resins in light fading. We show the relative effect. Dyes are also included for which information on only one effect is known.

It will be noted in the table that, as the tendency to cause tendering increases, the tendency to become more sensitive to light fading after resin treatment increases.

Kunz (*16*) has suggested that it is the quinone or paraquinoid structure of the dye which is the point of activation in tendering. It is possible that, after the active dye forms hydrogen peroxide photochemically, the hydrogen peroxide in the presence of resins releases free radicals, which reduce the quinoid group in the well-known manner. This reaction has been studied in some detail by Rembaum and Szwarc (*15*). It was referred to in our earlier paper (*1*) as a possible mechanism for the effect of resins on dyes.

The reaction would take place, through the formation of peroxide generated by the dye under light, on the resin to form free methyl radicals. These in turn could reduce the quinoid group irreversibly by forming methoxyl groups as indicated.



This reaction could result in destruction of the effectiveness of the molecule as a dye and in fading of the shade.

If this mechanism is correct, peroxide or free radical inhibitors should counteract it.

EFFECTIVENESS OF INHIBITORS ON LIGHTFASTNESS—— Despite the knowledge for many years of the number of useful vat dyes which show a tendering action on cotton, there has been only a limited quantity of work done on means of inhibiting this effect. As pointed out above, it has been shown that a trace of copper in the vat dyebath will reduce the effect. Two patents disclose materials claimed to inhibit the effect (*17, 18*). Salvin and Walker (*19*) have shown that inhibitors, such as unsaturated esters and organic amines, will combat the effect of ozone in the atmospheric fading of disperse dyes in hydrophobic fibers, such as acetate and Dacron. Unsaturated esters have been found effective as well as the organic amines.

If inhibitors could be applied along with the resin to control its effect in reducing lightfastness, it would be of great benefit. For this reason the unsaturated ester, diallyl phthalate, was selected as an agent which would be an acceptor of hydrogen peroxide and also an acceptor of free radicals with the thought that it might prevent the decrease in lightfastness if applied with the resin. This was done to a series of five sensitive dyes and a definite reduction in the fading effect after treatment with the methylated melamine resin was observed. The evaluation on the five dyes run is shown in Table VIII. The fading was essentially as though there was no resin present.

This is a positive discovery toward controlling the fading effect of resins on the vat dyes, but diallyl phthalate is not the practical answer as it is not effective at low concentrations, probably because of its high volatility during curing. Also, it does not seem to be as effective on the dimethylol ethylene urea resin, although time did not permit a careful study of it here. A further study of inhibitors will be made and may well bring forth a simple, practical solution to the problem of light fading of dyes by resin finishes.

TABLE VII

Correlation of light fading and tendering

Dye	*Effect of Resin on Light*	*Cellulose Tendering Properties**
Anthraquinone Vat Golden Orange RRT	none	inactive
Anthraquinone Vat Golden Orange 3G	reduced	active
Anthraquinone Vat Red FBB	reduced	active
Anthraquinone Vat Yellow 3R	reduced	active
Anthraquinone Vat Brilliant Orange RK	none	active
Anthraquinone Vat Yellow 5GLL	reduced	not known
Anthraquinone Vat Fast Yellow Paste	reduced	not known
Anthraquinone Vat Red Brown 5RF	sl reduced	
Anthraquinone Vat Violet VN	sl reduced	inactive
Anthraquinone Vat Scarlet R	none	inactive
Anthraquinone Vat Blue BCS	none	inactive
Anthraquinone Vat Khaki 2G	none	inactive
Anthraquinone Vat Olive R	none	inactive
Anthraquinone Vat Jade Green (Supra type)	sl reduced	sl active

*Fox (*9*) & Landolt (*13*).

TABLE VIII

Effect of an inhibitor on the fading effect

Dye	*Control*	*Melamine Resin*	*Resin and Inhibitor*
Yellow 5GLL	4	3	4
Brown R	5	5/4	5
Pink FF	3	3	3
Red FBB	4/3	3/2	4/3
Golden Orange 3G	4	3	4

EFFECT OF RESINS ON DYE MIXTURES——Evaluation of the effect of the various resins, including the nonnitrogenous resins, on compound shades dyed from combinations including certain of the sensitive dyes show no effect other than what would be expected from the knowledge of the action of the sensitive dyes when used alone.

As pointed out by Fox (9) and others, dyes which are inactive in light tendering will in some cases counteract the tendering action of active dyes when dyed in a combination. Therefore it would not be unexpected, from the knowledge of the action of active dyes which cause tendering under light, that combinations of sensitive and insensitive dyes could be found which would not be as sensitive as the sensitive dye by itself. Investigation of this effect is warranted.

PROPOSED EXPERIMENTS

1) Additional experiments are needed to confirm that the mechanism of the light fading promoted by resins is a peroxide mechanism, particularly to determine its nature and the function of free radicals. This suggests a quantitative study of other peroxide inhibitors including inhibitors which are specifically free radical chain breakers, such as the materials used in polymerization chemistry to stop free radical type polymerizations.

2) From a practical standpoint, further study of compound shades should be made to determine whether any of the unaffected dyes will protect dyes with lightfastness sensitive to resin treatment just as some nontendering dyes will counteract the tendering effect of active dyes.

3) A further key to the reaction may lie in the anomalous behavior of Anthraquinone Red FBB. For inexplicable reasons, in some experiments it shows a pronounced effect from the resin whereas in other experiments the resin has no effect on its lightfastness.

4) An interesting side study would be to determine whether the redox potential of the active dyes changes in the presence of resins on the fiber. The question is whether such a measurement will predict whether the resin will promote reduction of the dye on the fiber.

5) It is still of interest to determine whether the phenomenon of radiation antagonism is a factor in the effect of resins on lightfastness of dyes, as it is not ruled out by our latest discoveries.

SUMMARY

It has been established that a variety of chemical types of cross linking resins caused increased light fading with certain vat dyes. The common chemical grouping in these materials is one which can give a

This common grouping in the types of resins investigated is $-CH_2OH$ and

Although the effect of the two groups on the dyes varied somewhat, it was basically the same.

A correlation has been established between those types of dyes whose lightfastness is sensitive to resin treatment and dyes which degrade cotton photochemically as a result of peroxide generation.

It has been hypothesized that the peroxide developed by the dyes causes the generation of free radicals from the resins, which in turn cause an irreversible reduction of the quinoid linkage in the dye. Consequently, a free radical and peroxide inhibitor has been tested and found effective in controlling the fading in the presence of the resin. This is the greatest practical contribution of the paper.

The effect of the resin on the light fading of the sensitive dyes is only dependent on the concentration up to some point between one and five percent. The exact concentration depends on the particular dye. Above this critical concentration there is no increase in the rate of fading with increase of the concentration of the resin. Curing is not necessary to produce the effect and at most it only increased it slightly. The catalyst need not be present to cause the effect and its presence causes no increase in the effect. Zinc nitrate in some cases appears to reduce the effect. It may be stopping the generation of free radicals.

The increase in light fading of the sensitive dyes is more or less a linear function of the time, as with extended fading it does not show much proportionate increase over that occurring at shorter times. There are a few dyes which show an increase in fading on long exposure with no fading on short exposure. However, they are relatively insensitive.

A study was made of the effect of resins on shades dyed from mixtures of dyes. These did not show any significant change in the effect of resin from that which would be expected on the basis of the effect on the individual dyes. However, from a practical standpoint, a protective effect in some combinations is not precluded as it would be predicted from the behavior of dyes causing tendering which in some cases lose their tendering effect in combination with certain inactive dyes. This follows as it has been shown that the sensitive dyes in lightfastness are in general those which cause tendering.

ACKNOWLEDGMENTS

The Committee is indebted to many individuals and companies for contributing to its work by supplying materials, by doing laboratory work and by providing personnel to participate in the guidance of the committee.

We especially want to thank Fred Fortess and V S Salvin of the Celanese Corporation of America for a critical analysis of our data and the suggestion of experiments leading to our final conclusions. We are also indebted to the Research Department of the Dan River Mills, Inc, for doing the major part of our laboratory work. The voluminous work of evaluating our fading tests was done by John V Killheffer of the Du Pont Company with assistance from some others.

In addition, assistance is acknowledged from: Cone Mills Corp; Cranston Print Works Co; E I du Pont de Nemours and Co, Inc; Graniteville Co; North Carolina Finishing Co; North Carolina State College, School of Textiles; Riegel Development Laboratories; Rohm & Haas Co; Vikon Chemical Co.

REFERENCES

(1) Piedmont Section, AATCC, *Am Dyestuff Reptr* **45**, No. 23, P821-32 (1956).
(2) Giles, C H, *J Soc Dyers Col* **73**, 127, (1957).
(3) Smith, P W, *ibid* **65**, 743 ff (1949).
(4) Rhode Island Section, AATCC, *Am Dyestuff Reptr* **43**, No. 1,P6-13 (1954).
(5) "Effect of Zeset S on the Shade and Fastness of Dyed Textiles." E I duPont de Nemours & Co, Inc.
(6) Private communication.
(7) Shepard, S E, *Chem Rev* **4**, 319-53 (1927).
(8) Scholefield and Goodyear, *Textilber* **10**, 867 (1929).
(9) Fox, M R, *J Soc Dyers Col* **65**, 528 (1949).
(10) Egerton, G S, *ibid* **65**, 764 (1949).
(11) Ashton, D, Clibbens, D, and Probert, M E, *ibid* **65**, 650 (1949).
(12) Bamford, C H, and Dewar, M J, *ibid* **65**, 674 (1949).
(13) Landolt A, *ibid* **65**, 659 (1949).
(14) Waly, Preston, Scholefield and Turner, *ibid* **61**, 1245 (1945).
(15) Rembaum, A, and Szwarc, M, *J Am Chem Soc* **77**, 4468 (1955).
(16) Kunz, *Dyer* **72**, 27 (1934).
(17) German Pat 743,221.
(18) British Pat 582,143.
(19) Salvin, V S, and Walker, R A, *Textile Research J* **25**, 571 (1955).

Delaware Valley and New York Sections—

LIGHTING FACTORS TO BE CONSIDERED IN TEXTILE COLOR MATCHING*

WARREN B REESE
Macbeth Daylighting Corp
Newburgh, NY

INTRODUCTION

THE human eye is indeed a most remarkable and highly developed precision mechanism. As colorists, your eyes are employed as precise and critical detectors for which there is no electronic substitute. So it occurred to me that a discussion on light, which is the substance that stimulates your eyes, might be of sufficient interest so as to occupy your mind and offset what your seat must endure.

It will be necessary for you to lend me your imagination while we explore together the subjective realm of light and color as applied to color matching.

Color is a powerful and exciting force, which is indeed dynamic and complicated. As a nation we are color conscious, and having made our pot of gold we now want the rainbow that is supposed to go with it. While our conception of gold is universal, we see the rainbow from different angles. Color, like music, exerts a vital external fascination and allows individual expression. And so it is that we find color as a dynamic force, which is unpredictable, sometimes bold, sometimes subtle, and often damnable.

Perhaps we tolerate this precocious child called "color" because it is glamorous and attracts attention, and as a result sells more and more textiles. Color employed as a device to increase the volume and rate of goods turned over is, in a sense, like the hand that feeds us, accompanied by a more than occasional temptation on the part of the dyer to bite back at that hand for all the trouble that it causes him.

The more color is employed, the greater the burden which must be borne by the color matcher, especially since a color match in today's quality-conscious market must be more accurate than it has ever been.

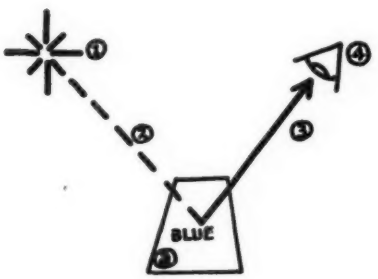


Figure 1

Color matching is an art, not a science, and is practiced by individuals possessing what might be described as a pair of "educated eyes". These educated eyes are constantly employed as critical detectors of small color differences. Light must be employed with which to see the samples in order to make a color judgment and it is therefore my intention to establish the relationship and importance of the light source as an aid to the colorist in his color-matching work.

DISCUSSION

Let us start at the beginning by breaking the perception of color down into its basic components. Figure 1 does just this. Color perception starts with the light source shown by 1, which radiates its energy shown by 2 and illuminates the blue sample labeled "a". The light is modified by the blue sample in that some of it is absorbed and the rest is reflected as shown by 3 and is detected by the eye labeled 4. This schematic diagram simply illustrates that the light which is reflected to the eye, which produces a color sensation, is dependent upon two factors—the sample and its source of illumination.

We can take this a step further and develop a simple concept of the more complicated color perception that takes place when a color matcher is discriminating the color difference between two samples. Figure 2 will illustrate this. Again we have the light source labeled 1 radiating the energy shown by 2 and illuminating the two red samples labeled 3 and 4. As before, the light source is modified by the two samples. In this instance, however, the samples are modifying the same light differentially because they are not the same color. The modified light is reflected, shown by 5 and 6, and the color difference between the two reflected rays of light shown by 7 is detected by the eye labeled 8.

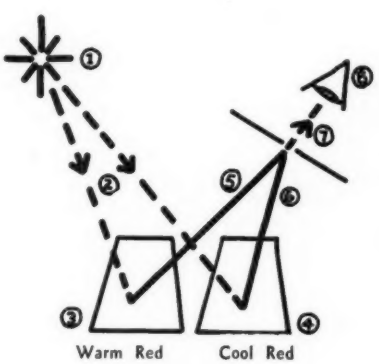


Figure 2

Bear in mind that the only fixed attribute of a colored sample is its ability to selectively absorb and reflect light. Therefore, what we see is most certainly a function of the light source. If we agree that the colored samples which parade past the dyer's eyes represent an uncontrolled variable and the light source which he uses to view the samples as a relative constant, then it is clear that the only area which we can profitably investigate is the light source itself since it is the only part of the color perception equation about which we can do anything.

Perhaps we may find some useful information by analyzing the light source since we have seen up to this point that color is not only "how we see it" but also "how we light it."

*Presented before the Delaware Valley Section at Reading, Pa on September 28, 1956 and the New York Section at Rochelle Park, NJ, on November 16, 1956.

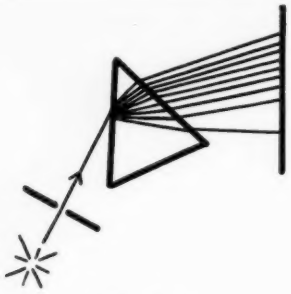


Figure 3

Figure 3 is a schematic diagram showing a single ray of white light entering the left side of an optical glass prism. Because light is composed of different wavelengths of energy, we find that each wavelength is refracted differently. The long wavelengths or red part of the light energy are bent the most while the short wavelengths or blue part of the spectrum are bent the least. In this manner the light source is spread out into a color spectrum, which we are unable to do with the naked eye. The light source spectrum so produced indicates that light, just as dye formulas, is composed of a blend of colors and therefore has a definite spectral energy distribution.

Now we have a means by which light sources can be analyzed and compared. Figure 4 shows the form in which light source analytical information might be presented. We have a single ray of daylight passing through a prism and spread out into its color components. If we measure the amount of energy present on the vertical axis of the graph for each wavelength or spectrum color on the horizontal axis we can plot a curve. This curve is called the light source spectral energy distribution.

Now let us take a look at some characteristic curves for some common light sources and compare them with the actual light sources.

Figure 5 shows a curve for an incandescent light, which appears to be yellow. This confirms that there is more yellow, orange and red energy present than blue and green, which accounts for the yellowish appearance of the incandescent lamp.

In Figure 6, the dotted line is a characteristic curve for a light source that is a duplication of the light from a moderately overcast north sky. The solid curve is for natural north daylight. Both curves show that all colors are present in the light, with a little more blue than the others, which accounts for the bluish white cast of north light. This graph also indicates how closely man-made light compares with natural daylight.

Figure 7 shows the curve for a cool, white fluorescent light source. From this curve we note that there is very little red and violet energy present, and there are four mercury gas spectrum lines also present. From this type of noncontinuous light energy distribution it is hard to predict how the light source will appear to the eye except to say that it will be a coldish grey.

You may be wondering at this point how this fits in with color perception. I submit that you may engage in light source color perception by viewing the three abovementioned lights in three different compartments when

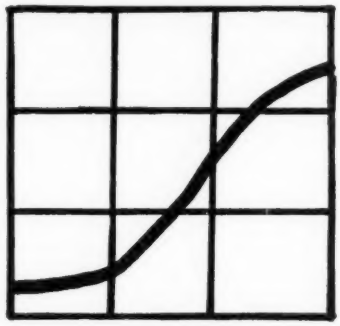


Figure 5

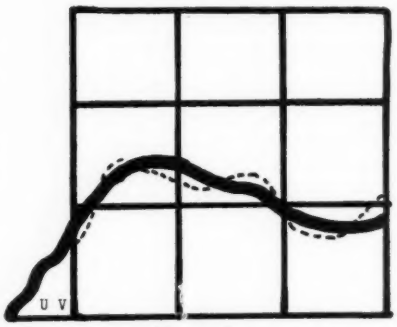


Figure 6

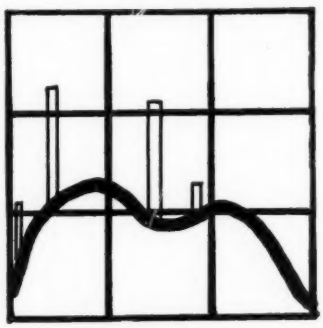


Figure 7

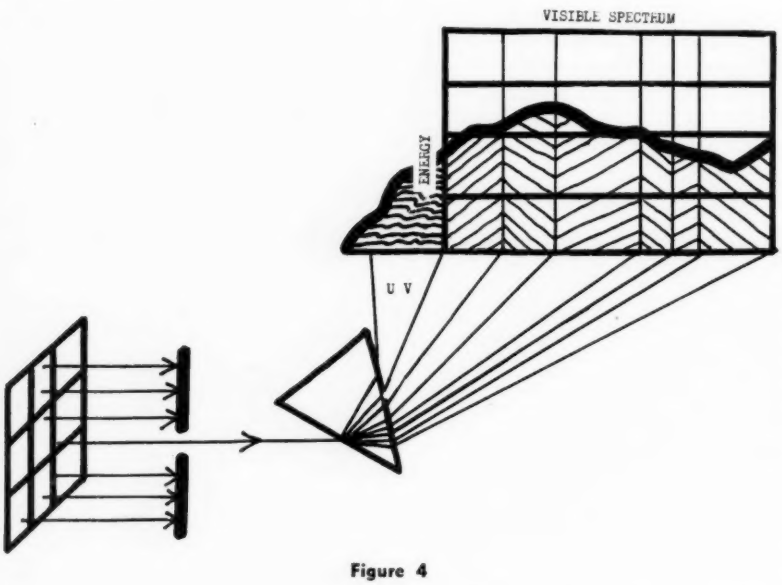


Figure 4

the white background in each compartment is the same. It is interesting to then contemplate the question, "What is white?" What you would see actually would be three different whites, but a side-by-side comparison would make you conscious of their color differences, which actually are due to the differences in the color composition of the light sources.

By introducing the same red color sample under each of three light sources, we could see how the differences in the light source composition affects our color perception. Under incandescent light, the white sample takes on a pinkish white tone. Under the fluorescent, the color appears muddy. Under artificial north sky daylight, the color appears a blue white (which agrees with what you would see under natural north sky daylight on a slightly overcast day).

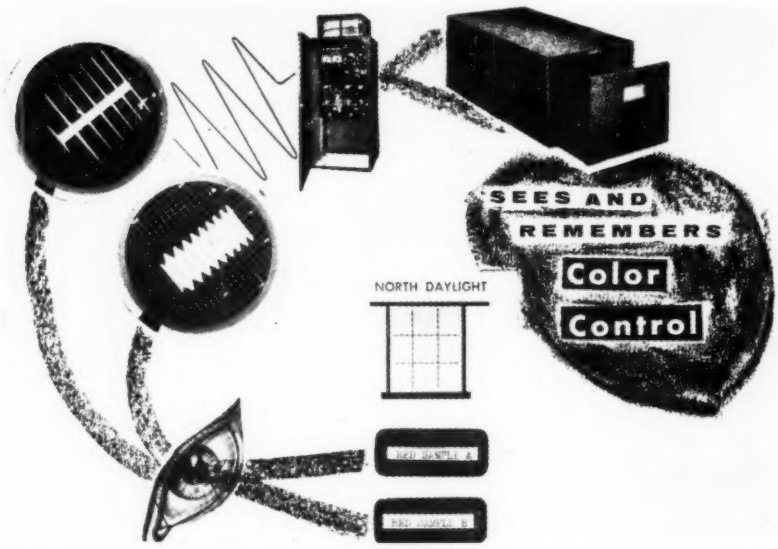


Figure 8

And so it goes for other sets of colors.

We are now at a point where we can discuss exactly the role light does play in color matching, the light source that should be used and why.

THE ROLE OF LIGHT——By first establishing the sequence of events which takes place when a colorist matches colors, we have the logical starting point from which to weave the whole fabric which will cover these searching questions. Figure 8 represents such a sequence. Daylight falling on the sample and standard is modified and reflected onto the retina of the color matcher's eye. An electric impulse or signal is generated for each sample and a separate color sensation is produced. The color difference between the two color samples so perceived produces another electrical impulse characteristic of this color difference, which energizes the brain's computing mechanism. The computer searches its color experience and color memory storage files and selects the best answer. In this manner the color matcher, through his educated eyes, sees and remembers what corrective action or adjustment he should make to resolve or reduce the color difference and thereby obtain color control.

There are two important factors in this sequence.

The first is the color matcher's experience. Two individuals can detect visually the same color difference, but if one has color-matching experience, then he has a basis for interpreting the color difference into corrective measures to be taken in the dye formula to obtain a closer match; the other, having no practical color-matching experience, has no basis for interpretation of what corrective steps are to be taken. This is a very important factor which I will touch on again later. This is also the reason that instruments can not perform a color-matching function; for even though they can detect color differences better than the human eye, they can not convert this information into dye formula adjustments quickly, efficiently, and economically.

The second factor is the light source, which triggered this chain of events in the first place. It is clear that the color matcher obtained his original color experience with some light source and that all his experience is referenced to that light source. Now, if a different light source is used to trigger the chain of events, the character and amount of color difference will not be the same and the computing mechanism will not be referenced properly, thereby producing an answer or interpretation which will be in doubt or error.

If a difference in light source can upset the color matching function, it is evident that the upset is due to a difference in the light source color composition or spectral energy distribution. This sounds familiar, recalling the earlier discussion on light-source color analysis, and it would seem that I am now meeting myself coming around the corner. Nevertheless, the next two illustrations will put the final pieces into place and solidify the discussion up to this point.

Figure 9 indicates daylight which has been spread out into its spectral components and is illuminating a red triangular object. The red object, remember, has the property of rejecting or absorbing all the color in the light except the red portion which is reflected. This reflected red light, upon entering the eye, will create a

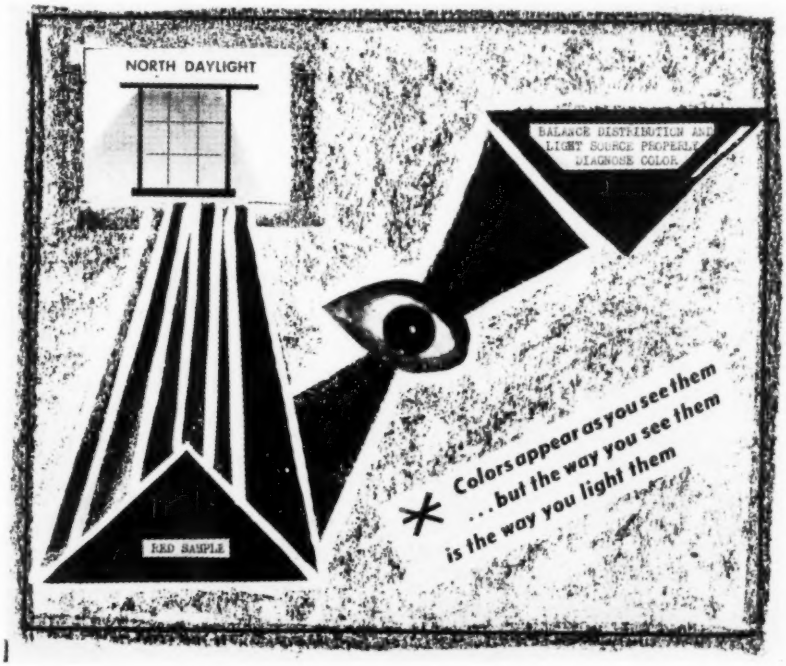


Figure 9

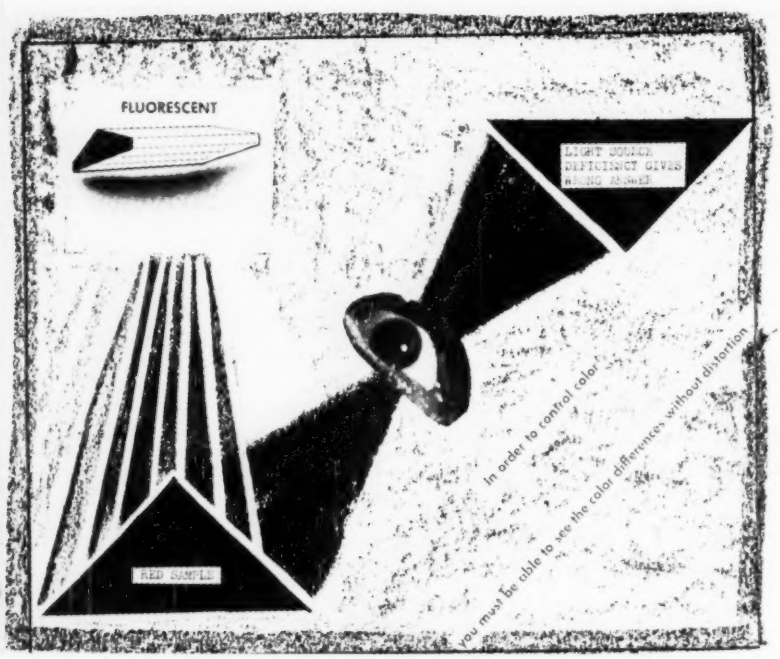

FLUORESCENT
LIGHT SOURCE DEFICIENCY GIVES RISING RESULT
RED SAMPLE
In order to control color
you must be able to see the color differences without distortion

Figure 10

red color sensation which will be the same as the real object if this is the lighting condition to which the observer is accustomed.

Figure 10 shows the same thing except that the daylight source has been replaced with a fluorescent light source. The light is broken up into its spectral components and we note, compared with daylight, there is a deficiency of red and colored spectrum lines present. The same red triangular object absorbs most of the light and reflects what little red light is present. This reflected light is incomplete as to its red content and, upon entering the eye, produces a sensation of an apparent color which is different from the object's true color as seen under daylight. This results in uncertainty in the mind, as the brain mechanism has been triggered improperly. These two examples simply give strength to the statement that we can not see color in objects without distortion unless the color is in the light source to begin with.

SELECTION OF LIGHT SOURCE ———Assuming that I have now established the role of the light source in color perception to your satisfaction, we can move on to the matter of what light source should be used and why.

The answer to the remaining question can not be a scientific one because of the subjective aspects of the entire matter. The key to this question is acceptability. A light source for color matching is only an aid, or means to an end and not an end in itself. It will not match the colors for you. If the light source is not acceptable to the colorist it is useless as a tool. In order that a light source be acceptable to the colorist it must be compatible and comfortable. In short, the light source and color matcher must go together as naturally as storks and mothers.

What light source is acceptable? Well, this question was answered by the Inter-Society Color Council's Problem 13 Subcommittee, which investigated and recommended the illuminant for textile color matching (*1*). The AATCC, which is a member body of the ISCC, requested that this committee be set up to study this problem. The committee was formed in 1943 and was composed mainly of textile colorists. The committee completed its work in 1948, almost five years later, and published its final report and recommendations. I would be pleased to send reprints of these reports to those wishing to review them in detail. For now, a capsule résumé of the committee's report should suffice. The committee first made over a thousand measurements and observations of intensity and quality of natural daylight at various mills. These measurements were correlated with each color matcher's identification of what he considered to be very good daylight conditions so that data could be obtained upon which to specify preferred natural lighting conditions. A nearly unanimous preference for the light from a moderately overcast north sky with a minimum intensity of 100 footcandles resulted. With this data, electric light sources meeting these requirements could be tested to determine the suitability of substituting the artificial source for the natural one. (An experimental voltage-controlled test set-up was actually built, which included various filters to produce several qualities of D/L and light meter readings were employed to verify preferred intensities.) This test was independent of the natural daylight studies. The artificial sources were varied over a wide range and the color matchers were again asked to select the artificial lighting condition which they preferred. Again, when the results were measured and tabulated, they indicated a preference for an artificial light equivalent to that which radiates from a moderately overcast north sky. This confirmed the color matchers' original choice in the natural daylight studies. Finally the last test was designed to determine the suitability of substituting the artificial source for the natural source. This test consisted of five series of colors totaling 29 samples, which were matched by the colorists under various electric light sources and natural daylight. When the results were compared, the best agreement was obtained under both natural and artificial sources having a quality of light equivalent to a moderately overcast north sky.

The committee's final recommendation was that an artificial illuminant to satisfy preferred conditions of daylight match should produce a spectral energy distribution equivalent to that of natural daylight from a moderately overcast north sky or a color temperature of 7500° K with an intensity of not less than 75 or more than 300 footcandles. Figure 11 shows the curve for natural daylight on the left, and on the right, the curve for artificial daylight produced by incandescent lamps and Macbeth filters, which meets the recommendations and was used in the committee's work.

METAMERISM———It would appear now that we have the answer as to which light source, natural or artificial, should be employed for critical color matching and that the lighting problem for this critical seeing task has been solved. Unfortunately, this is not the case since no single illuminant, natural or artificial, can be designed so that a match ob-

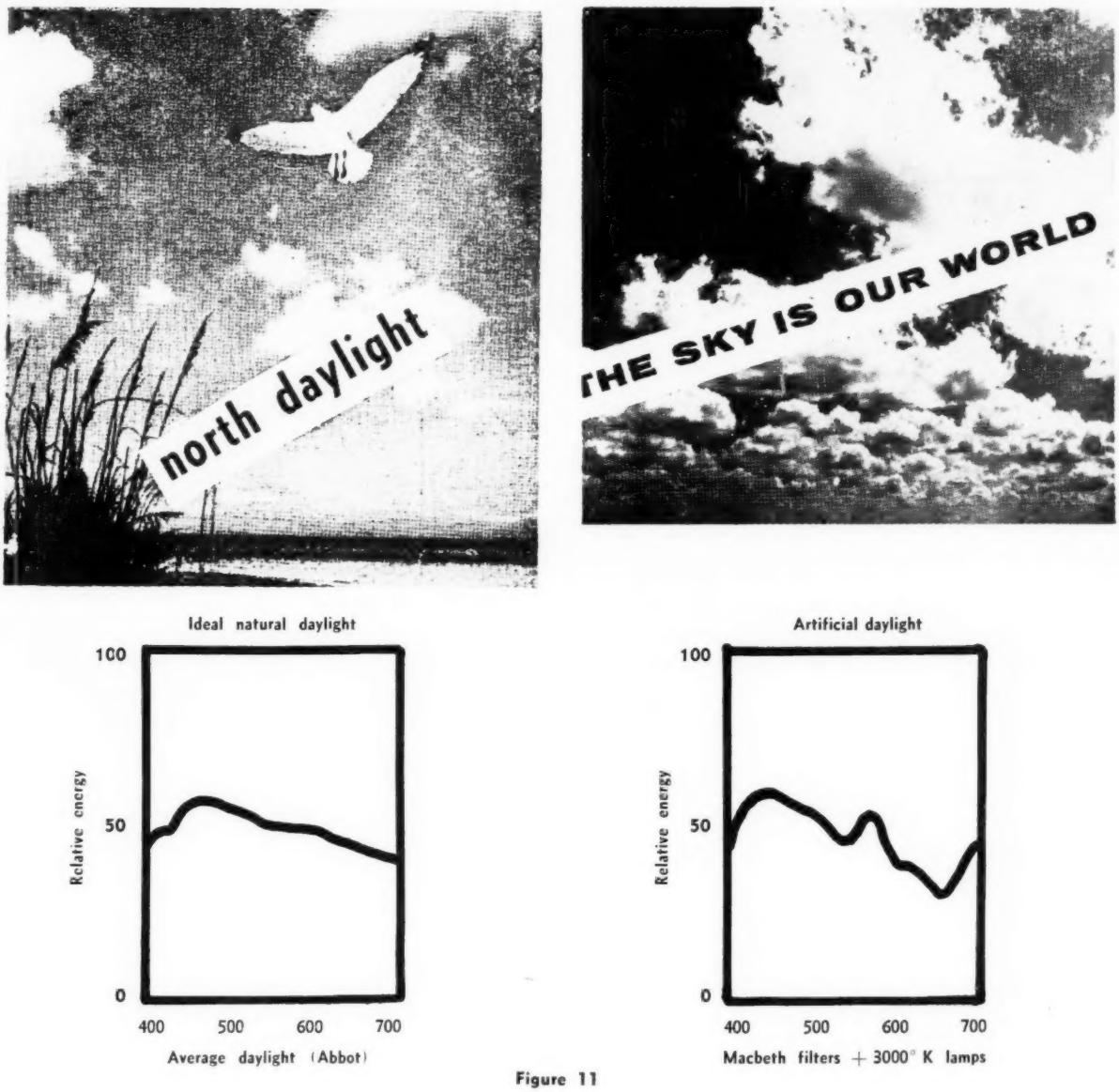


Figure 11

tained under that single illuminant will prevail under all illuminants. I am, of course, referring to that damnable characteristic of color matching, technically called metamerism.

A typical example of a pair of colors which are metameric is illustrated in Figure 12. The actual samples were illuminated by fluorescent light and might be considered to have been a loose commercial match. When these samples were removed from under the fluorescent light source and placed under an incandescent light source a dramatic change was noted in that one sample turned Kelly green and the other turned reddish brown. From the curves it may be seen that the samples have similar characteristics in the blue and green portion of the spectrum and their differences are the greatest in the red region of the spectrum. These curves of the actual samples explain why the colors appeared to match under daylight fluorescent since it is basically a cold light source deficient in red and therefore accentuates the similarity of the curves for the two samples in the blue and green region of the spectrum. Since the incandescent lamp has its greatest energy content in the red and orange regions of the spectrum, it easily can be seen from the curves that the differences of the samples in this region of the spectrum are magnified and the samples appeared to be a gross mismatch.

All color matching involving the matching of a sample whose dye formula or colorant mixture is unknown usually is associated with some degree of metamerism. From this example it follows that metameric matches can be detected only by the use of two light sources rather than a single light source. We have already established that the preferred primary reference light source should be equivalent to a moderately overcast north sky. The second light source should be greatly different from this in order to bring out metamerism so that it can be easily detected. Therefore, the second light source should be yellow-orange in character, such as the light which is characteristic of

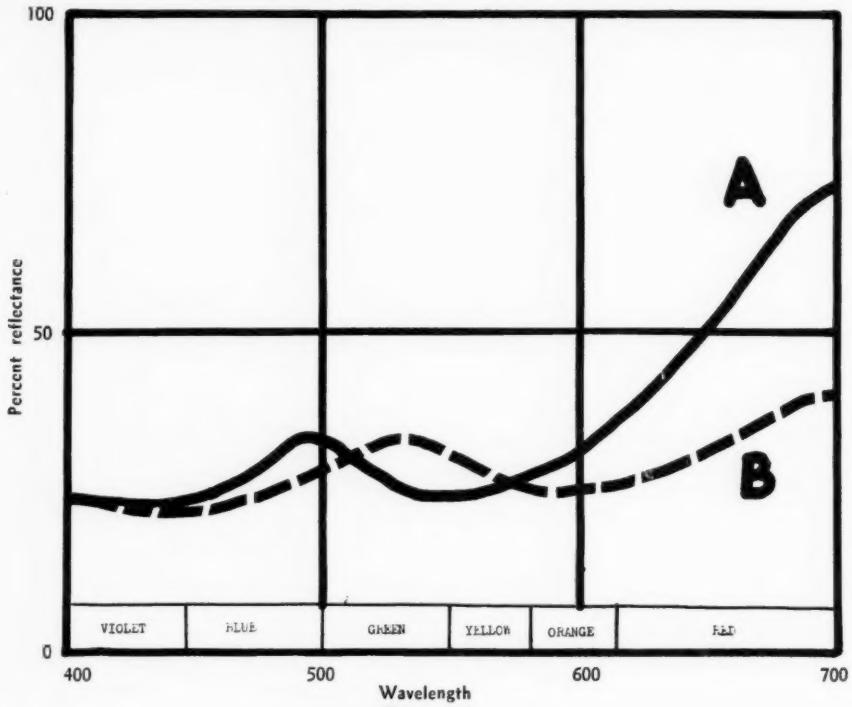


Figure 12
Spectral reflectance curves of two textile materials which are a metameric color match

horizon sunlight. The further apart the two illuminants, the more easily metameric matches are detected. I have been extremely careful not to infer that metamerism can be corrected, for oftentimes it can not. There is, however, merit to the philosophy that, to be forewarned is to be forearmed, and hence early detection of metamerism before the customer learns about it is advantageous. Many times metamerism can be reduced by dye formula adjustment, and in some instances it can be completely eliminated. Wherever two colors may be made to match under both north sky daylight and horizon sunlight, the same colors will match under light sources in between, including fluorescent.

STANDARD VIEWING PROCEDURE——I should like now to touch briefly upon the standard viewing procedure of some of the major automotive manufacturers. Figure 13 is a schematic diagram showing the relationship between the overhead light source, the surface of the viewing table and the position of the observer. If suppliers can view their color matches under the same viewing conditions as the customer, the probability of acceptance is increased. If the conditions were not standardized, then the color matcher is truly at the mercy of the customer as he does not know beforehand the nature of the viewing conditions which will be used by the customer to approve or reject his color match. Since a light source must be used by both the dyer and the customer, better it be a source acceptable to the dyer. I am sure that many of you would like to discuss this further, as there are many factors which time does not permit my developing further. I would, however, like to state that standardized lighting and viewing conditions in the hands of customers do not guarantee intelligent interpretation of the materials viewed thereunder. You will therefore be amused when I categorically deny any responsibility for the decisions made under these viewing conditions but will, I hope, agree that standardized conditions are at least better than nonstandardized conditions.

Since it appears that artificial light sources can be satisfactorily substituted for natural daylight, there are distinct advantages in forsaking Mother Nature. The most obvious advantage is constancy and twenty-four hour availability, plus the fact that color-matching stations can be truly standardized from place to place within the mill, between mills and between mills and customers so that everyone will start out from the same bench mark.

Even though perfect light source and viewing conditions may be installed, much has been said about the ability of people to see color. As a result a number of tests have been developed to determine whether an individual has defective color vision and to measure his color aptitude. Unfortunately these tests on numerous occasions have not been properly understood and have therefore been applied incorrectly. I thought I would make a few remarks on this subject in order to set the record straight once and for all.

To begin with, one male out of ten and one female out of a hundred has some defect in his or her color vision. A defect in color vision can be compensated for by experience and therefore can not be a just cause for dismissal alone. In other words, those colorists who are doing a satisfactory job in industry and who may have a defect in their color vision should be left alone. If they are not doing a satisfactory color-matching job they would be removed from their position whether they had a color defect in their vision or not. The same remarks apply to color-aptitude tests. I suppose I am drawing a line beween individuals already employed as colorists and personnel who might be selected for training to become colorists. Color perception tests and color - aptitude tests are indeed a useful tool to select trainees in industrial color-matching work. It certainly makes sense to

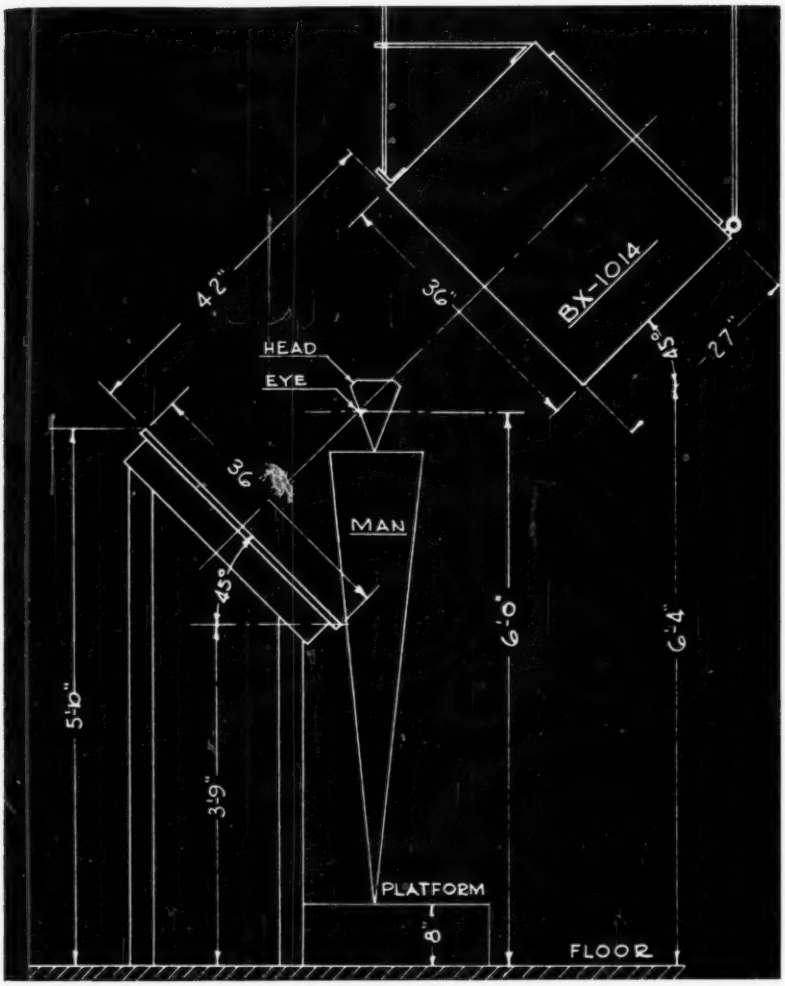


Figure 13

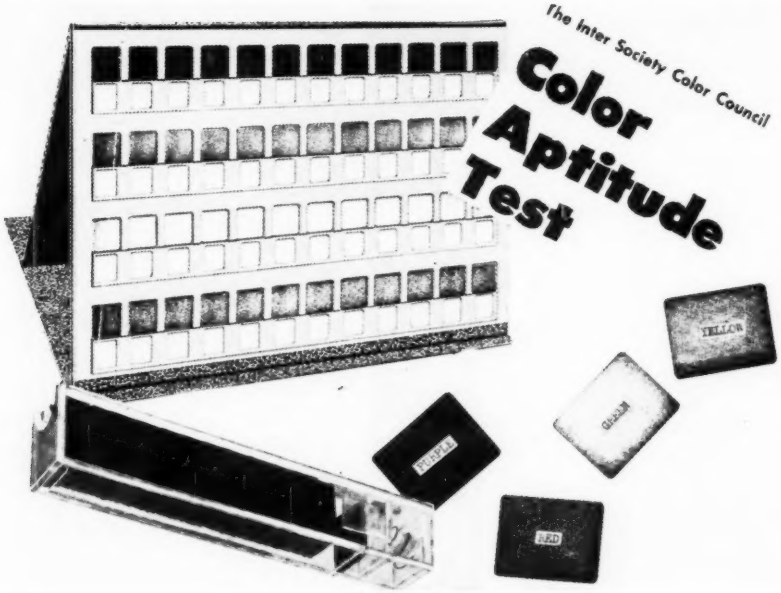


Figure 14

believe that selected people having normal color vision and good color aptitude have the best statistical chance to return industry's investment in time and money in training these people for this difficult work. This is actually the area where these tests have their proper place and maximum value.

Figure 14 shows the Inter-Society Color Council Color Aptitude Test. This test consists of four hues, blue, red, green and yellow, with twelve shades for each hue. The chip holder at the lower left contains color chips arranged in random order. Each chip is a match or a near match of one of the chips on the easel. The test requires approximately forty-five minutes to match each of the chips in the holder to the chip on the easel. After each judgment the chip is returned to the holder before the next chip is removed. The score is marked on the chart underneath the easel. When the test has been completed and the results tabulated a numerical scoring system indicates whether the individual tested has an unsatisfactory, a poor, fair, good or excellent color aptitude. It is interesting to note that no test can be devised which will predict in advance whether an individual, even though he may have an excellent color aptitude, will be able to absorb his color experience so that it can be used in future color-matching work to adjust dye formulas with a minimum number of trials. Actually there are some cases of people having only average color aptitude who are able to absorb training and experience better and in the end make better color matchers, so you can see that the entire subject of color blindness and color aptitude tests is indeed a philosophical one.

Before closing I should like to show you a few examples of lighting installations for various types of textile color matching and inspection problems which are currently in use. (See Figures 15-18). Bear in mind that these installations, including the quality of illumination produced, are all based upon and in conformance with the basic studies and recommendations made by the AATCC-inspired Inter-Society Color Council Problem 13 Committee.

CONCLUSION

In closing, we can sum up briefly the factors having to do with light sources as employed in textile color matching as follows:

1) Color is not only how we see it but also how we light it.

2) If the color is not present in the

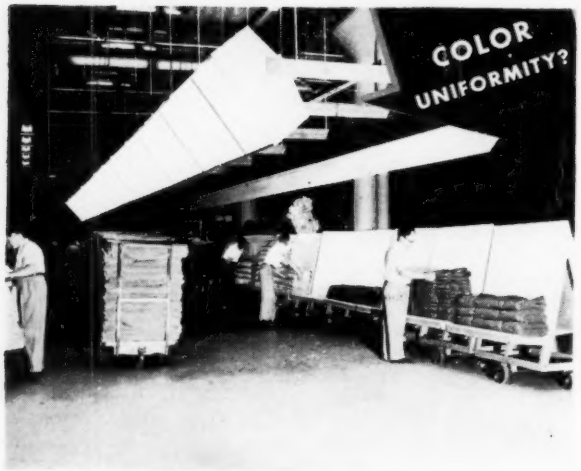


Figure 15

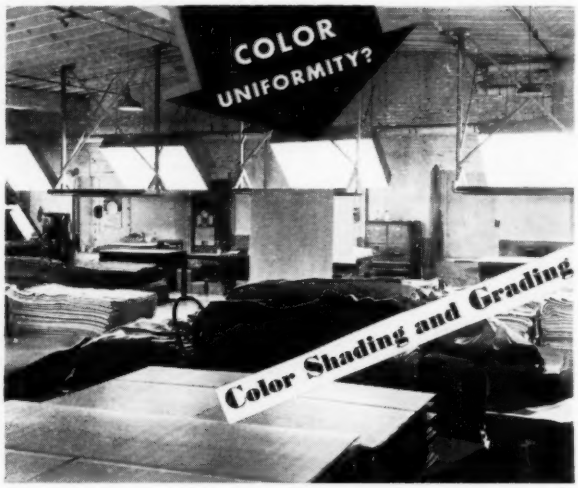


Figure 16

Figure 17

Figure 18

light source to begin with, it can not be seen in the object and color distortion is introduced.

3) Color matching is an art, not a science.
4) An electric light source for color matching must be acceptable to the colorist.
5) The only light source acceptable to the colorist is a duplication of preferred daylight conditions, which was investigated by the ISCC Problem 13 Committee.
6) Two illuminants are required for color matching for the detection of metameric color matches. The two best illuminants are north sky daylight and horizon sunlight.
7) Artificial daylight must accurately duplicate natural daylight and should be used at an intensity of between 75 and 300 footcandles.
8) Color blindness and color aptitude tests must be thoroughly understood and administered with care. They have their greatest value in screening and selecting new personnel.
9) The surrounding conditions should be neutral to avoid color distortion due to color confusion.

REFERENCES

(1) O'Neil, F J, "Illumination for Textile Color Matching", *Am Dyestuff Reptr* **36** No. 12, P329-30 (June 16, 1947).

(2) Hardy, A C "Handbook of Colorimetry", Technology Press, Cambridge, 1936.

(3) Nickerson, D, "The Illumination in Color Matching and Discrimination", *Illuminating Eng* **36**, 373 (1941).

(4) Taylor, A H, and Kerr, G P, "The Distribution of Energy in the Visible Spectrum of Daylight", *J Opt Soc Am* **31**, 3 (1941).

(5) Nickerson, D, "Artificial Daylighting for Color Grading of Agricultural Products," *ibid* **29**, 1 (1939).

(6) Nickerson, D, "Artificial Daylighting Studies", *Trans Illuminating Eng Soc* **34**, 1233 (1939).

(7) Nickerson, D, "Computational Tables for Use in Studies of Artificial Daylighting", U S Dept of Agriculture, Agricultural Marketing Service, 1940.

(8) Judd, D B, "Specifications of Uniform Color Tolerances for Textiles", *Textile Research* **9**, 253, 292 (1939).

(9) Gage, H P, "Filters for Artificial Daylighting, Their Grading and Use", *Trans Illuminating Eng Soc* **31**, 995 (1936).

AATCC Calendar

COUNCIL
May 23 (Philadelphia, Pa); Sept 19, 1958 (Charlotte, NC)

NATIONAL CONVENTIONS
Oct 30-Nov 1, 1958 (Hotel Conrad Hilton, Chicago); Oct 8-10, 1959 (Sheraton Park and Shoreham Hotels, Washington, DC); Oct 6-8, 1960 (Sheraton Hotel, Philadelphia, Pa); September 28-30, 1961 (Buffalo, NY)

HUDSON-MOHAWK SECTION
Jan 24, Mar 28 (Jack's Restaurant, Albany, NY); May 16 (Ladies Night, Chelsea House, Tribes Hill, NY); June 20 (Annual Outing, Antler's Country Club, Ft Johnson, NY)

METROPOLITAN SECTION
Feb 7 (New York, NY); April 11 (New Jersey area)

MID-WEST SECTION
Feb 15 (Hotel Bismarck, Chicago, Ill); April 19 (Netherland Hilton Hotel, Cincinnati, O); June 13-14 (Outing—Browns Lake Resort, Burlington, Wis)

NIAGARA FRONTIER SECTION
Feb 21 (Buffalo); Apr 11 (Joint meeting)

PIEDMONT SECTION
Apr 25-26 (Washington Duke Hotel, Durham, NC); June 6-8 (Outing—Grove Park Inn, Asheville, NC); Sept 19-20 (Hotel Charlotte, Charlotte, NC)

SOUTHEASTERN SECTION
Feb 15 (Hotel General Forest, Rome, Ga)

Membership Applications

SENIOR

Nelson G Bourret—Asst color shop foreman, Cranston Print Works Co, Cranston, RI. Sponsors: J A Placella, E S Johnson. (RI).

John W Bowen—Colorist, E I duPont de Nemours & Co, Inc, New York, NY. Sponsors: B F Quigley, J S Thackrah. (Met).

Stephen P DeMallie—Technical assistant to the president, Callaway Mills, Inc, New York, NY. Sponsors: C A Whitehead, J F Hagen. (Met).

Ben Goldfield — Owner - operator, Custom House, Scottsdale, Ariz. Sponsors: D L Hood, C H Brubaker. (PS).

James R Heard—Technical sales engineer, Penick & Ford, Inc, Atlanta, Ga. Sponsors: G M Anderson, P G Wear. (S).

Guy S Herrick—Development chemist, American Cyanamid Co, Bound Brook, NJ. Sponsors: W R Howes, F Fordemwalt. (Met).

O Litvay—Tech dir, chief chemist, Lanco S/A Industria Quimica, Sao Paulo, Brazil. Sponsors: S F Balcerzak, E Grieder.

James D Loper—Colorist, E I duPont de Nemours & Co, Inc, New York, NY. Sponsors: B F Quigley, J S Thackrah. (Met).

William M Lybrand—Supt, Fiberglas finishing, J P Stevens, Inc, Slater, SC. Sponsors: R C Horton, H S Falls. (P).

Edward S Mattos—Dyer, American Velvet Co, Stonington, Conn. Sponsors: R W Canavan, J E Lawton. (RI).

Ira M Schafer—Tech service-chemist, Morningstar-Nicol, Federal Latex Div, New York, NY. Sponsors: R Morningstar, J Snoop. (Met).

William E Smith—Textile chemist, E F Houghton & Co, Philadelphia, Pa. Sponsors: A D Nute, G O Linberg. (DV).

Harold F Williams—Plant supt, Newport Finishing Corp, Fall River, Mass, Sponsors: W E Murray, R A Pingree. (RI).

ASSOCIATE

William O Crank—Southern mgr, "Textile World", McGraw-Hill Publishing Co, Atlanta, Ga. (S).

Francis Etzel Jr—Asst national accounts mgr, Morton Salt Co, New York, NY. (Met).

Stuart Lyman—Research dir, Grace-Lee Products Inc, Minneapolis, Minn. (M).

Cornelius Westerhoff—Chemical engineer, Naugatuck Chemical Co, Naugatuck, Conn. (WNE).

JUNIOR

Carlos V Uribe—Asst supt, Pantex, Medellin, Colombia. Sponsors: J G Stass, T A Bivens.

Eugene M Posniak—Colorist, E I duPont de Nemours & Co, Inc, New York, NY. Sponsors: B F Quigley, J S Thackrah. (Met).

STUDENT

Preston G Baker—Student, North Carolina State College. Sponsor: H A Rutherford. (NC).

David B Shaughnessy—Student, Lowell Technological Institute. Sponsor: G R Griffin. (L).

Richard A J Turner—Student, New Bedford Institute of Technology. Sponsor: F Tripp. (NB).

Employment Register

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the secretary of the Association, Post Office Box 28, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the secretary.

Education: BS, textile chemistry, Lowell Technological Institute (1957); business administration, Univ of Connecticut.
Experience: Summer employment in following fields: management, retail foods company; finishing department, finishing company; dyehouse, textile manufacturer; development chemist, chemical manufacturer; student instructor (1 year).
Age: 23; single; references; draft status: 4A.
Position desired: management training program in textile chemical field.
Location desired: open.
1-27; 2-10

58-2

Education: chemical engineering, Univ of Nancy (France); chemical engineering, dyestuffs and textile chemistry, Warsaw Institute of Technology.
Experience: 11 years, technical agent, Polish branch, French dyestuff manufacturer; 6 years, supervisor, wool dye department in dye application laboratory of dyestuff manufacturer; 6 years plant chemist in leading Canadian woolen and worsted manufacturing company.
Age: 51; married; references.
Position desired: dyestuffs laboratory; quality control; research; wool-worsted plant chemist; technical sales.
1-27; 2-10

58-3

Education: BS, textile chemistry, Lowell Technological Institute (1957).
Experience: student instructor; chemist, plastics manufacturer.
Age: 28; single; references.
Position desired: textile chemist.
Location desired: East or Mid-west.
1-27; 2-10

Our apologies to Georgia Tech. . . .

The attractive drum majorette pictured on page P975 of the December 16th issue, Miss Paula Stevenson, is a co-ed at Georgia Tech, not Clemson College.

Miss Stevenson was correctly identified as Tech's first co-ed in textile chemistry in our January 13th issue, page P20.

ACTIVITIES OF THE LOCAL SECTIONS

Delaware Valley

THE Delaware Valley Section, at its "Old Timers' Night" meeting, held Dec 6 at Kugler's Restaurant, Philadelphia, Pa, honored its charter members, past chairmen, Olney Medal winners and other Section members who have held national offices in the AATCC.

John M McChesney, president, Leatex Chemical Co, Philadelphia, was acclaimed the Section's initial "Man of the Year" in a surprise ceremony and a "This is Your Life" type of presentation.

Guest speaker of the evening was Sidney M Edelstein, chairman of AATCC's Archives Committee.

Charter members in attendance were Russell Hunt, Franklin Processing Co, and Percival Theel, Philadelphia Textile Institute.

Of the Section's 29 past chairmen, 12 were in attendance: Edward Diehl, Ankokas Dyeing & Finishing Co; Thomas H Hart, Hart Products Corp; John F McCoy, Edgewater Dyeing & Finishing Co; James Dixon, formerly with American Cyanamid Co; William Ebersold, formerly with James Lees & Sons Co; Arthur M Gordon, J B Martin; Frederick V Traut, Globe Dye Works Co; Ange E Raimo, John Campbell & Co; Robert Sullivan, Anchor Thread Co; Harold Dohner, Amalgamated Chemical Co; Richard B Stehle, Brehm & Stehle; and Donald W Robinson, Para-Chem, Inc, outgoing chairman.

Clarence Seibert, Scholler Bros, program chairman, was assisted in the preparation and presentation of this special meeting by Messrs Hart and Diehl.

THE Educational Committee of the Delware Valley Section has announced a new series of lectures on

COLLOIDS AND RESINS

The lectures will be presented in six sessions, covering basic principles as well as the practical applications of these principles in the preparation, dyeing and finishing of fibers and fabrics.

The series will be presented on successive Monday evenings beginning March 3rd from 7:30 to 9:30 at the Philadelphia Textile Institute.

Cost of the course will be $12.00 plus the textbook.

Applications may be made by writing to:

Educational Committee
Delaware Valley Section, AATCC
P O Box 5025
Philadelphia 11, Pa

Metropolitan

HENRY E MILLSON, manager, Technical Laboratory, Dyes Dept, Organic Chemicals Div, American Cyanamid Co, will address the Metropolitan Section (formerly the New York Section) at its February 7th meeting at the Sheraton McAlpin, New York, NY. His subject will be "The High-temperature Microdyeoscope."

Niagara Frontier

THE Niagara Frontier Section held its last meeting of 1957 on December 6 at Canisius College, Buffalo, NY, with 22 members in attendance.

Featured speaker at the meeting was Nelson F Getchell, National Cotton Council of America, who spoke on the subject, "Cotton." He illustrated his talk with numerous exhibits illustrating the use of the newer chemical treatments including acetylation, mildewproofing, flameproofing, and various resin treatments.

Reviewing events of the past 10 years, the speaker noted that in 1956 the use of cotton in industrial fabrics had declined over quantities used in 1946, but stated that it had increased its position in the wearing apparel field during this same period. Of all fibers in use today, both natural and man-made, cotton was said to amount to 66% of the total. New techniques in agriculture had resulted in crop yields of 416 lbs cotton/acre in 1957, compared with 271 lbs/acre in 1950 and 251 lbs/acre in 1945. The newly developed U S Supeema was said to be equal in quality to Long Staple Egyptian cotton.

R Childs, chairman of the Nominating Committee, proposed the renomination of the 1957 slate of officers, as follows: *Chairman*—William H Leyking, National Aniline Div; *Vice chairman*—Kenneth A Lister, Canadian Industries Ltd; *Treasurer*—Anton Viditz-Ward, Van Raalte Co; *Secretary*—Norbert Weinberg, Becco Chemical Div; *Councilor*—Bernard K Easton, Becco Chemical Div; *Sectional Committee*—J Wallace, chairman, N Mohoruk, D Boland, S Puliafico. The entire slate was elected.

The treasurer's report was read by Mr Viditz-Ward, and Messrs Leyking and Easton reported on the Council meeting held during the Boston Convention.

Western New England

GUEST speaker at the December 13th meeting of the Western New England Section, held at Rapp's Restaurant, Shelton, Conn, was Fernand Schlaeppi, chief New England technician for Ciba Co, Inc.

Thirty-five members and guest were present to hear Mr Schlaeppi discuss "Some Aspects of Dyeing with Linkage Dyes".

Notable guests included George O Linberg, AATCC president, and Ernest R Kaswell, AATCC vice president, New England Region.

Reprints Available . . . .

COLOUR INDEX—CROSS INDICES

A limited number of reprints of the Colour Index — Cross Indices, which was published in the August 26th and September 9th issues of the REPORTER, are available. Both installments are included in a single reprint form at a price of $1.00 per copy or 75¢ per copy for quantities of ten or more.

Send check or money order to:

American Dyestuff Reporter,
44 East 23rd St,
New York 10, NY

Prices include cost of mailing.

AATCC MEMBERS ARE URGED TO NOTIFY THE SECRETARY'S OFFICE OF ANY ADDRESS CHANGE.

Abstracts

Inertness, Covering Power and Thermal Pliability of Dynel Acrylic Fiber

Swalm, J M, *Can Textile J* **74**, 49-53, Sept 6, 1957.

Dynel fiber is made from 60% vinyl chloride and 40% acrylonitrile, and is spun from a solution in acetone. In many respects it resembles in its physical properties the other acrylic fibers, including resistance to mildew, insects and burning.

The fiber is noted for its inertness; it is unaffected by strong detergents, drycleaning solvents, and most other organic chemicals. It has a very low moisture regain (0.4%), and in consequence dries rapidly. A tendency to develop static charges can be controlled by the use of certain antistatic finishes, which are described.

When heated in air under minimum tension, Dynel is stable up to 250° F; above 265° shrinkage becomes quite pronounced. Under medium load (eg, in a tenter frame) it starts to stretch at about 200° F, but at 250° shrinkage forces begin to reverse the action.

Regular Dynel in its natural color is supplemented by spun-dyed Dynel in 11 different colors, and by a high-bulking fiber (Type 63 Dynel), which shrinks 25% in boiling water.

For dyeing, the disperse, neutral premetallized and cationic dyes may be employed. They are applied at temperatures close to the boil, giving a full range of shades of acceptable fastness. Acid dyes may also be applied, using the cuprous ion process. The fiber has a tendency to delustre when dyed at 205 F. The luster can be restored by dry heat at 240 F, by semidecating with steam, or by treating with boiling Glauber's salt solution.

Type 77 Dynel (18 denier) closely resembles carpet wool, and is said to have good wearing qualities and soil resistance as a carpet fiber.

Dynel is blended with cotton to produce underwear of superior warmth, and with wool to make a fabric of increased durability and wear life. In blends with rayon it imparts crease retention.

The flame resistance of Dynel gives it an advantage for draperies, military applications, and other uses where resistance to ignition is important. The draperies and bedspreads of the liners *United States* and *America* are said to be 100 percent Dynel.

Industrial uses include filter cloths, work clothing, and air filters. The fiber is said to be particularly suitable for paint rollers.—WHC

Carbonizing Wool Stock ———An Improved Sulfuric Acid Method

Anon, *Can Textile J* **74**, 51-4, Nov 1, 1957

Removal of vegetable matter from raw wool by treatment with acids (eg, sulfuric acid), followed by heating, is commonly known as "carbonizing".

It is well known that carbonizing can severely damage wool fibers, particularly when the process is not properly controlled. Even under controlled conditions, some fiber damage occurs, and losses of from 5 to 20% of wool during subsequent mechanical processing have been estimated. These losses are mainly caused by weakening of wool fiber through acid attack, followed by excessive breakage of the damaged fibers and their separation. In these cases, the amount of fiber lost depends upon the type of wool and the nature of the manufacuring operations.

Recent laboratory experiments and mill trials in Australia have shown that the addition of surface-active agents to the sulfuric acid bath prevents excessive loss in fiber tensile strength, and thereby improves the yield of carbonized wool. These agents also improve the efficiency of removal of the undesirable vegetable matter. Additional benefits are a reduction in ends down in spinning and greater tensile strengths of the resultant yarns and fabrics.

Data presented by the author, based on laboratory trials, indicate that all three types of surface-active agents (anionic, nonionic and cationic), when added to the carbonizing acid, are very effective in minimizing losses to yarn tensile properties during this treatment.

In a full-scale mill trial reported by the author, when a nonionic surface-active agent was added to the sulfuric acid bath, an increase of 4.4% in the weight of higher quality carbonized wool stock was obtained. The increase can be attributed to less damage to the wool fibers during carbonizing, which results in a reduction in the number of fibers broken and lost during the mechanical removal of brittle vegetable matter. In addition, the cloth produced from wool carbonized with addition of surface-active agent showed a greater tensile strength.

The author gives suggestions for the proper amount of surface-active agent to be added, and describes the carbonizing process in great detail.—WHC

Dyeing Cellulosic and Noncellulosic Fibers with Vat Dyes

Bardt, K J, *Can Textile J* **74**, 61-5, Oct 4, 1957.

The author suggests ways of eliminating some of the difficulties in dyeing cotton and viscose packages, beams, raw stock and viscose cakes.

When applied by the caustic soda/hydrosulfite leuco technique, vat dyes are known to have limitations in the following respects:

Leveling: Most vat dyes have a higher rate of strike and less tendency to relevel than any other dyestuff class.

Over-reduction: The Indanthrone Blues are over-reduced by elevated temperatures in a bath of a high redox potential.

Swelling: Under certain circumstances, in alkaline media, this swelling action can make penetration and circulation of the dye liquor through viscose rayon packages or cakes quite impossible.

Loss of redox potential: When approaching neutral or slightly acid dyebath conditions, hydrosulfite decomposes rapidly and causes the redox potential to drop substantially.

The author points out that, when sodium sulfoxylateformaldehyde is used instead of hydrosulfite in a vat dyebath, reduction takes place very gradually at temperatures around 140°F. Optimum conditions are approached at temperatures between 190° and 200°F. At this temperature, a redox potential is established which is comparable (expressed in millivolts) to one of a bath containing sodium hydrosulfite as a reducing agent in approximately equal quantities. However, when immersing a vat yellow test paper, the bluish coloration takes place only after 8 to 10 seconds of immersion.

In a sulfoxylate dyebath, the rate of strike is kept low in the temperature zone 100-160°F, where the most highly substantive vat dyes, such as anthraquinone violet, tend to dye rapidly and do not level well. When full reduction at 190-200°F is reached, the rate of strike is still low and the ability to diffuse and level greatly enhanced. Sulfoxylate leucos are very stable and it is not necessary to add more reducing agent even after dyeing for two hours in an open machine at 200°F.

If the exhaustion of the dyebath is relatively low with some dyes an addition of one gpl of hydrosulfite near the end is recommended by the author.

(*Concluded on page 62*)

• PATENT DIGEST •

PAUL WENGRAF

CREASE- AND SHRINK-PROOFING EFFECTS——— Condensates of Pentaerythritol with Dialdehydes G,2,04

USPat 2,785,996 (Quaker Chem Products—Kress—March 19, 1957)

The preamble to this patent refers to resin condensates of the polyacetal type obtained in the past as water-insoluble and infusible products by condensing penta erythritol $C(CH_2OH)_4$ with glyoxal. USPat 2,643,236 (Kropa and Thomas) is quoted in this connection (see reference below). It has been observed, however, that these two components condense under very strong acidic conditions only, precluding their use in textile processing.

In contrast, it has been found that *higher, water-soluble dialdehydes*, eg, succinaldehyde, condense with pentaerythritol fairly well under mildly acidic conditions, imparting durable crease resistance to textiles. Two to four CH_2-groups separating the two aldehyde radicles give appropriate results, while higher homologs are sparingly soluble. Practically, succinaldehyde, glutaraldehyde and hydroxy adipic aldehyde or substitution products thereof with equal chain length are preferred. It might be assumed that pentaerythritol forms a linear polymer with the dialdehyde. Instead of pentaerythritol, di-, tri-, pentaerythritols or higher ethers may enter into these reactions.

Example: An aqueous solution of 4.5% 2-hydroxy adipicaldehyde, 4.5% pentaerythritol and 1% oxalic acid was prepared. Rayon gabardine was padded in this solution with a pick-up of 100%, dried at 180° F and cured at 315° F. The tests, following the ATCC tentative method 66-53, reportedly showed superior results obtained with condensates of the above-mentioned dialdehydes.

Among the references cited by the Patent Office:

USPat 2,436,076 (Cluett Peabody/1948): stabilization against shrinkage effected by a treatment with glyoxal in presence of an acidic catalyst.

USPat 2,643,236 (Am Cyanamid/1953): obtaining infusible glass-like resinous products by condensing pentaerythritol with glyoxal under strongly acidic conditions.

SOLVENT SOLUTIONS OF METALLIC SOAPS——— Gluconic Acid as Viscosity Reducing Agent G.2,O2

USPat 2,785,989 (Am Cyanamid—Davis, Winston—March 19, 1957)

Metallic soaps dissolved in organic solvents have notably good waterproofing properties. A great disadvantage in this special application, however, is their property of *gel formation* at relatively low concentrations (above 2-3%) which renders them useless for sprayable coatings or waterproofing compositions. Some peptizing agents, such as phenols or tartaric acid, are undesirable because of the corroding character of the compounds. The object of the current invention is to provide a relatively high concentrated metal soap solution of low viscosity.

This problem reportedly has been solved by adding a pentahydroxy monocarboxylic acid, eg, *gluconic acid*, $C_5H_7(OH)_5COOH$, or its stereoisomer, *mannonic acid*, to the metallic soap-forming components.

Example: A sodium soap solution formed from a fatty acid mixture "Hydrofol 405" (70.5 p stearic, 28 p palmitic, 1.5 p myristic and 6 p unsaturated acids) was dissolved in water and heated to 60-70° C. An aqueous solution of alum mixed with (50%) gluconic acid was stirred in. The precipitated metal soap could be filtered off well. After being dried at about 70°C the soap was soluble to an extent of 15% in toluene or Solvesso at room temperature as well as at 75° C, and the solution remained thin and clear, easily sprayable for waterproofing purposes.

Among the references cited by the Patent Office:

USPat 2,223,158 (National Oil Prod/1940) discusses a free-flowing metal soap dissolved in chlorinated or non-chlorinated hydrocarbons, characterized by the addition of an oil-soluble mineral oil sulfonate (Mahogany soap).

USPat 2,350,688 (National Oil Prod/1944) discusses a metal soap solution in which the acid component is 12-hydroxystearic acid.

BLEACHING OF COTTON GOODS———Solvent Treatment Followed by Desizing and Bleaching B,2

USPat 2,790,699 (Imp Chem Ind——White——April 30, 1957)

The severe alkaline kier pretreatment in conventional cotton goods bleaching is replaced in the current invention by a two step-method: 1) natural waxes and oil residues which adhere to the fabrics are removed in a warm solvent bath, such as trichloroethylene, then 2) after the goods are freed from the solvent, they are desized and bleached at the same time by padding in an alkaline solution (about pH 11) of a percompound, eg, sodium peroxide, squeezed and steamed for a very short time.

Main advantages of this method are said to be: 1) long, costly and possibly fiber-attacking kier boiling is avoided; 2) the short solvent treatment is far more efficient in removing natural waxes than the standard alkaline preboiling process; 3) the dewaxed and de-oiled goods are quickly desized by oxidative transformation of the starch and (at least partly) bleached at the same time. The current process is said to render the fibers highly absorbent despite the extremely speedy treatment.

Pretreatments with volatile solvents to remove the natural waxes admittedly are known, but this step is *not intended to replace the alkaline scour* as in the current patent. The wax content (after the solvent treatment) is found to be as low as 0.1-0.3%; this small percentage does not further impair the adsorbency of the goods. The period of immersion in the solvent may be from a few seconds up to one minute. A 30-second extraction with hot trichloroethylene, for instance, is said to produce a residue of only 0.2% waxes. The solvent must thereupon be removed, eg, by flashing it off in a passage through hot water. The solvent is then easily recovered for further use.

Example: Cropped and singed raw cotton fabric (drill or duck) was passed within 30 seconds at open width through two closed vessels containing boiling trichloroethylene; then carried for 10 seconds through boiling water to flash off the solvent; padded in a bath containing 10 g sodium peroxide, 5 g sodium silicate and 0.5 g of a nonionic detergent of

the Igepal type to a wet pick-up of 150%; steamed for one minute, rinsed, neutralized and dried.

Among the references cited by the Patent Office:

USPat 2,173,040 (Muller/1939): desizing of textiles by applying solutions of persulfate or other percompounds.

USPat 2,267,718 (Du Pont/1941) discusses a continuous textile-treating process comprising an alkaline impregnation in a J box, followed by steaming instead of kier boiling.

USPat 2,549,014 (U S Rubber/1951): improving the tensile strength of grey cotton by first treating in an alkaline bath, then with hot solvents, particularly of the alkyl acetate (amyl acetate) type.

USPat 1,398,378 (Rockland Fin Co——Jacoby/1921): increasing the strength of cotton yarns by removing part of the natural waxes with solvents such as benzene, ethyl ether or the like.

WATER-REPELLENT FABRIC———Dispersions of Oxydimethylene-Bis-Acylamides G,2,02

USPat 2,793,142 (Du Pont——Brace——May 21, 1957)

N-N′-oxydimethylene-bis-acylamides are ether-type products of the general formula: R-CO-NH-CH_2-O-CH_2-NH-CO-R′ wherein R and R′ are higher aliphatic chains of 9-29 C atoms. R and R′ may be identical or different, generally comprising $C_{17}H_{31}$ and/or $C_{17}H_{35}$ groups. Oxydimethylene-bis-acylamides of the above formula are prepared by condensing two hydroxymethylamides . . . R.CO-NH(CH_2OH) . . . in an inert medium under carefully observed, mildly acidic conditions; otherwise, eg, in presence of stronger acids, N-N′ methylene-diacylamides . . . R-CO-NH-CH_2-NH-CO-R′ . . . result. The latter compounds leave readily removable, thus useless residues on the fiber. In contrast, the oxydimethylene-bis-acylamides protected by the current patent decompose upon heating on the fabric, depositing the resulting methylene diacylamides as substances firmly linked to cellulose (col 3, lines 49-59).

The products covered by the present patent are applied in the form of a dispersion. The dispersing agent may be a polyoxyalkylene derivative of sorbitan monostearate or stearamido methyl pyridinium chloride, having no rewetting properties after curing. Polyvinyl alcohol, sodium alginate, etc, may be added as protective colloids.

Example: A dispersion of 20 g N-N′-oxydimethylene-bis-stearamide, 20 g 10% aqueous polyvinylalcohol solution, one g stearamidomethyl pyridinium chloride, and one g pyridine in 58 g water was padded on a fabric with a dry pick-up of 2%. The goods were cured at 350° C for 2 minutes without intermediate drying, neutralized with soda ash, rinsed with dodecyl sulfate detergent, and finally dried at 350° C. The fabrics so treated did not develop unpleasant odors and the dispersions were stable in storage, imparting a durable water-repellent effect. They can also be combined with various acid-curable resins in order to add other properties to the fabrics such as stiffness or crease resistance.

Among the references cited by the Patent office:

USPat 2,425,392 (Nopco Chem Co/1947): diamides consisting of two fatty acid-amido groups, the N-atoms being linked by alkylene groups or by alkylene interrupted by an ether linkage, may be used as textile lubricants.

USPat 2,676,936 (Du Pont/1950) covers a textile-finishing composition consisting of a dispersion of a methylol fatty acid amide mixed with an aqueous polyvinylalcohol solution and a higher alkylsulfate.

HYDROPHOBING OF TEXTILES———Organosilicones plus Zirconium Compounds G,2,02

US Pat 2,789,956 (Wacker Chemie GmbH——Eder——Apr 23, 1957)

Water-repellent treatments with organic silicon compounds in polymerized state generally require high curing temperatures, thereby sometimes damaging the fiber structures; moreover, unsatisfactory efforts in the treating of cotton goods and insufficient stability upon washing reportedly have been observed.

The current invention seeks to improve the results by pretreating or aftertreating organosilicone - treated goods with zirconyl salts or by effecting both treatments *simultaneously*. In the latter event, the organosilicones logically have to be applied in the polymerized state in the form of an aqueous emulsion and an aqueous solution of the zirconium compound has to be stirred in (see example below). Suitable emulsifying agents are of the quaternary ammonium salt type, eg, benzyl trimethylammonium chloride. In the first-mentioned two-step process, textiles are prepared with an aqueous, buffered and acidified zirconium salt solution, squeezed, dried, and impregnated with a solvent solution of the silicon monomer that is subsequently polymerized *in situ*.

The specification mentions, among others, zirconyl chloride, zirconyl nitrate, etc, or the so-called basic zirconyl salts $Zr_2O_3Cl_2$ or [$ZrOCO_3$ $(NH_4)_2CO_3$] ie, zirconylammonium carbonate, as appropriate compounds. They are present in an amount of 0.2-2% of the emulsion's weight.

The essential effect of this method is that the curing temperature can be lowered considerably while improvement of the hydrophobic effect and better resistance to washing and drycleaning are rendered.

Example: Methylhydrogen polysiloxane dissolved in methylene chloride was emulsified with benzyl trimethylammonium chloride to give an emulsion of 20% silicone content. A 10% aqueous zirconylchloride solution containing glacial acetic acid and sodium acetate as a buffer was stirred in at room temperature. Woolen samples were dipped into this liquid and cured for 5-10 minutes at 130-140° C. The water-repellent properties reportedly were retained after repeated washing and drycleaning cycles in contrast to organosiliconeprepared textiles in which the zirconium compounds had been omitted.

Among the references cited by the Patent Office:

USPat 2,453,562 (Gen Electric/1948): solid, elastic, curable methylpolysiloxanes are prepared by incorporating into polymerizable mixtures of methylsiloxanes an amount of zirconyl nitrate sufficient for curing.

USPat 2,482,816 (Nat Lead Co/1949): hydrophobing of textiles with the acetic acid co-ordination compound of basic zirconylacetate and sulfanilic acid [cf *Am Dyestuff Reptr 38*, 957 (1949)].

USPat 2,687,388 (Nat Distillers Corp/1954) discusses a liquid solution, stable at normal temperature, containing solvent-soluble phenyl methyl siloxanes and zirconium naphthenate and zirconyl stearate as hardening agents.

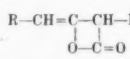
STABILIZING REGENERATED-CELLULOSIC TEXTILES by Reacting with a Higher Ketene Dimer G,2,04

USPat 2,791,484 (Am Viscose Corp——Cafasso——May 7, 1957)

The objects of the current invention are to safeguard textiles composed of viscose rayon (filament or staple) against dimensional shrinkage; to provide, at the same time, improved resistance to rupturing by tearing or flexing; and finally, to im-

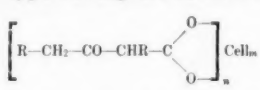
part greater softness to the treated goods.

The patented method is based on a reaction of regenerated cellulose with a *dimer of a higher aliphatic ketene* (an aldoketene) represented by the formula



in which R is any higher aliphatic chain from 10-20 C, such as octyl, capryl, octadecyl, oleyl, etc.

Although the nature of the reaction product with cellulose is not known positively, it is supposed to be of the acetal type having the formula:



wherein "Cell" stands for the residue of a cellulose molecule.

The dimer is emulsified in an aqueous medium by a nonionic emulsifier, eg, polyethoxylated sorbitan mono fatty ester (Tween or Span), to which is added any acid catalyst that will bring the pH down to 2.0-1.0. "Hand modifying" agents, such as water-soluble cellulose ethers or polyvinyl-acetate, may be combined with this finish. Textiles are padded in the emulsion at room temperature, dried at 240-250° F, baked for one to seven minutes at 300-350° F (preferably in tensioned condition), and finally scoured at 210-212° F and dried in a relaxed state.

Example: An emulsion containing about 4% hexadecyl ketene dimer and one of the above-mentioned nonionic surfactants was obtained by heating the dimer and the emulsifying agent on the steam bath and adding some hot water while agitating. Solutions of sodium bisulfate and sodium sulfate were stirred in and the balance of water was added. This emulsion had a pH of 1.3. A spun viscose fabric was padded in the liquid, dried at 240° F under slight tension, cured at 300° F, and scoured with a 0.5% soda ash solution and a one percent Igepon T solution for 10 minutes at 120° F.

A table shows the samples so treated to have considerably superior stability after five washing cycles carried out according to the CCC-T-191A Cotton Wash Test (Federal Specification) compared with samples not treated with the dimer emulsion.

Among the references cited by the Patent Office:

USPat 2,411,860 (Heberlein Patent Corp/1946): higher molecular ketenes are used for hydrophobing textiles [cf *Am Dyestuff Reptr 36,* 288 (1947)].

USPat 2,436,076 (Cluett Peabody/1948): stabilizing of cellulose with acid glyoxal solutions [cf *Am Dyestuff Reptr 37,* 475 (1948)].

USPat 2,627,477 (Hercules Powder/1953): higher alkyl ketene dimers, such as decyl or hexadecyl ketene dimers, having affinity for cellulose are employed in the emulsified state for sizing paper.

Brit Pat 522,204 (Deutsche Hydrierwerke/1940): similar to USPat 2,411,-860 (see above).

DYEING POLYACRYLONITRILIC MATERIAL——Pretreatment with Hydroxylamine Solutions C,4,07

USPat 2,792,276 (Pacific Mills——Kaupin, Patsourakos——May 14, 1957)

According to this patent, polyacrylonitrilic materials, ie, products such as fibers, films, molded articles, etc, containing more than 80% acrylonitrile, can be dyed by conventional methods by reacting the polymers with alkaline hydroxylamine solutions. Dyeing results are claimed to be superior to those obtained using phenolic assistants or other carriers. Although a wide variety of dyestuff groups, such as basic, direct, vat, etc, may be used (col 3, lines 31-33), the main objective is dyeing with acid dyes.

Since hydroxylamine per se is not available commercially and is unstable in the free state, the modification of the polyacrylonitrile material is carried out by employing its salts, eg, hydroxylamine chloride or sulfate. Enough alkali must be added to obtain the free base in a solution of pH 7-10 or higher, preferably of pH 8.5-9.0. The treatment of the polyacrylonitrile fibers is carried out at 160-225° F or at higher temperatures for 20 minutes to two hours. Typical hydroxylamine amounts range from 5-75% and preferably from 30-50% owf.

Example: A package of polyacrylonitrile top (Du Pont Orlon 41) was placed in a pressure vessel and eight percent of hydroxylamine hydrochloride in aqueous solution was added gradually at 120° F, after which a cold concentrated solution containing 6.6% sodium carbonate (based on weight of top) was slowly introduced. The pH was increased from 6.5 to 8.7 while the bath was warmed during 30 minutes to 200° F, and rose further to 9.1 after another 30 minutes. Thereafter the bath liquid was removed and the material rinsed with circulating cold water. Dyeing was carried out in the same kettle with a mixture of Calcocid Alizarine Sky Blue B (*C I* 1088), Anthraquinone Violet 3R (*C I* 1080) and Pontacyl Fast Black N2B (*C I* 304) in the presence of sulfuric acid. Temperature was raised first to 200° F, then, after an hour, to 250° F. The pH at the end of the operation was 2.4. After a scouring in the same kettle with 0.5% solution of an alkylsulfate detergent, a dark navy blue resulted.

The specification contains interesting charts proving the great difference in dye affinity between fibers modified according to the current method and nonmodified fibers. Spectrophotometric data show that the modified material, in contrast to regular polyacrylonitrile fibers, exhibits better penetration and uniform dyeing results.

According to col 11, lines 61-68, the modified fibers turn yellow and become insoluble in customary polyacrylonitrile solvents. Otherwise the physical and mechanical properties are not adversely affected.

Among the references cited by the Patent Office:

French Pat 905,038 (I G Farben Ind/1943) quite generally advocates a treatment of polyacrylonitrile fibers with alkali or acids in liquid or gaseous state to improve their dyeing properties.

USPat 2,497,526 (Du Pont/1950): polyacrylonitrile fibers are suspended in hydrazine solutions, thereby acquiring affinity for certain acid dyes [cf *Am Dyestuff Reptr 39,* 467 (1950)].

Reference may also be made to an article by Schonteden in *Melliand Textilber 38,* 65-8 (Jan 1957). The mechanism of the above reaction is explained as a partial conversion of the CN groups of the polyacrylonitriles to $-C(NH_2)$: NOH groups. The author reportedly has applied for patents covering dyeing of the fibers so prepared, for producing fibers in which the above products are incorporated, and for a process tending to eliminate the yellow tint of the products.

Abstracts——

(*Concluded from page 59*)

It is stated that there is no danger of over-reduction of the Indanthrone Blues when dyed at 190°F by this method.

The author gives full instructions for conducting the dyeing operation when using sulfoxylate. He warns that only vat dyes of fine particle size and perfect dispersability may be used.

The application of this method to the dyeing of Terylene/viscose and viscose/acetate unions is also briefly discussed.—WHC

News of the Trade

'58 Business Forecast to be Given at DCAT Meeting

A forecast of 1958 business conditions will be given the members of the Drug, Chemical & Allied Trades Section of the New York Board of Trade on January 30th at a Waldorf-Astoria luncheon, by H E Luedicke, editor of the *Journal of Commerce*.

Ralph A Clark, vice president of the J T Baker Chemical Co, is chairman of the committee arranging the luncheon.

International Operation of Cyanamid Coordinated

Coordination of all international operations of American Cyanamid Company in a single, new division was announced recently by W G Malcolm, president. The new division will be known as Cyanamid International.

"Our overseas marketing and production operations, which now extend over 80 countries and territories have reached the point where it is desirable, in the interests of better service to our customers, to integrate these activities," Dr Malcolm said.

Sidney C Moody, vice president for international operations and a director of the company, has been named director general of Cyanamid International. Assisting him the management of the division will be H F Bliss Jr as director of operations; R T Bogan, director of marketing; and E G Hesse, director of finance and administration. Each of these executives has had experience in various phases of the company's foreign operations.

Since World War II Cyanamid's overseas business has assumed steadily increasing importance in the company's overall growth record. Subsidiary and affiliated companies are operating in 14 countries, many having their own production facilities, while additional plants are nearing completion in other countries.

Mr Moody has seen 38 years' service with American Cyanamid and a predecessor, Calco Chemical Company, Inc, which Cyanamid acquired in 1929. He was elected a director of Cyanamid in 1944 and vice president in 1946.

Cyanamid is a major U S chemical company with more than 4 plants and 29,500 employees in this country and abroad. Company sales in 1956 exceeded $500 million.

Glacial Acrylic Acid Facility Nears Completion

The first facility in the country for making glacial acrylic acid in large commercial quantities is nearing completion at the B F Goodrich Chemical Company plant in Calvert City, Ky, according to John R Hoover, president of the chemical firm.

Located on a 2½-acre portion of the company's Calvert City site, the new unit is expected to be on stream in early 1958 and will have a capacity of several million pounds of glacial acrylic acid per year. Availability of the glacial product on this scale reportedly will offer important handling advantages to manufacturers now using water solutions of acrylic acid.

The new plant will be integrated for the production of acrylic resins as well as the acid. One of the related chemicals to be produced is Good-rite TS-20—a processing size for nylon.

The acrylic plant is the third unit of the B F Goodrich Chemical Company development in Calvert City. The first unit, a vinyl chloride monomer operation, opened in early 1953. This was followed by the acrylonitrile plant, which started production in 1955.

In addition to the establishment at Calvert City, the chemical company has manufacturing units at Louisville, Ky; Akron and Avon Lake, O; Niagara Falls, NY and Haledon, NJ. A plant is also under construction at Henry, Ill.

IHM Completes Purchase of Franklin Process

Indian Head Mills, Inc recently completed the purchase of the business and assets, subject to the liabilities, of Franklin Process Company for a cash purchase price of $5,831,080, a sum equivalent to $40 per share of the Franklin Process Company common stock now outstanding. The sale was approved by a required vote of more than two-thirds of the outstanding shares of common stock of Franklin Process at a special meeting of stockholders held Dec 10 in Providence, RI.

The business of the Franklin Process Company will be operated as a division of Indian Head Mills, Inc with no change in operating or management personnel.

New Scotchgard Promotion

A continuing and greatly expanded nation-wide promotion of Scotchgard brand stain-repeller, using the new theme of "The Spotless Look," is under way for the first six months of 1958, by Minnesota Mining and Manufacturing Co (3M), maker of the finish.

Built on the results of the firm's 1957 fall campaign in leading trade and consumer magazines and network TV shows the new promotion will be spearheaded by heavy magazine advertising and publicity, backed by at least 50 major in-store demonstrations nationally, complete merchandising kits, and—as a special feature—a series of movies for retail store education.

It is estimated the new drive will reach an even greater audience than the 100 million persons who in 1957 saw and heard the story of 3M's stain-repeller, reputedly the first oil-repellent fabric finish in the history of the textile industry.

The program centers on the theme that "a truly spotless look" is now available in men's wear, women's wear, and upholstery—the three major areas in which the stain repeller is now being applied.

27th Annual Meeting, ISCC

"Color in the Building Industry will be the theme of the Inter-Society Color Council's 27th Annual Meeting, March 25-26 at the Sheraton-Park Hotel, Washington, DC.

On Tuesday, March 25th, ISCC will hold a joint meeting with the American Society for Testing Materials' Committee E-12. This will be highlighted by an address by ISCC President Walter C Granville on the subject, "Color in European Buildings".

The annual business meeting will be held Wednesday morning, March 26th. During the afternoon, a symposium will be held under the general title of "Color in the Building Industry". Moderator will be Waldron Faulkner, program chairman for this Annual Meeting. At the Wednesday evening banquet, Julian Garnsey, a prominent colorist will address the group on the same subject.

Advance registration blanks may be obtained from Ralph M Evans, ISCC Secretary, Color Technology Div, Bldg 65, Eastman Kodak Co, Rochester 4, NY.

Seek Wider Use of Colors Soluble in Drycleaning Solvent

Means to obtaining a wider use of dryclean fast, resin-bonded pigment colors in textile printing will be studied as a result of a recent conference of technical representatives of the National Institute of Drycleaning and officials of a textile chemical manufacturing company and a printing concern. The meeting was called by the Institute in a move to stem the rising flood of complaints caused by improperly selected resin-bonded pigment colors, mainly on washable-type outerwear fabrics that fade when drycleaned.

The meeting took place at Institute headquarters in Silver Spring, Md, November 22. Those in attendance were: John Warner, vice-president, D B Fuller Co (division of J P Stevens Co) and an early developer of resin-bonded pigment printing techniques; Peter Shonk, sales manager of Interchemical Corp's Textile Colors Division; and Alfred Siepert, assistant sales service manager of the same firm. Representing NID were: Joseph R Wiebush, research director; W Clay Hardin, chief analyst; A Rothe, head spotting instructor; Dorothy S Lyle, consumer relations director; and Albert E Johnson, trade relations director and chairman of the meeting.

Mr Hardin advised the group that his department had investigated more than 1000 complaints of fading caused by colors that were not fast to drycleaning. He said this was the largest number of complaints of a single type ever handled by the Institute, thus reflecting a widespread situation. Though most of the complaints involve washable-type cotton garments, many types of nonwashable blends and synthetics are also seen, Mr Hardin said.

Mr Johnson reported that, in surveys conducted by the Institute, it has been found that more and more women are having their fashion cottons drycleaned although many of them—where styling permits—can be laundered. Even low-priced dresses of this type are being drycleaned today, he said. Mr Johnson warned that drycleaners are sensing the growing importance of this new market for their services and that they can be expected to promote the trend on an increasingly wider scale in the future.

Mr Warner said his firm has been aware of this trend for some time and that, whenever possible, they use pigment colors that are fast to drycleaning as well as washing. It was brought out in discussion that the new test TTM 85-57, Colorfastness to Drycleaning, of the American Association of Textile Chemists and Colorists, is acknowledged as a reliable means of checking the resistance of printed colors to fading in drycleaning.

Mr Shonk advised that demands for his company's resin-bonded pigment colors that are fast to washing and drycleaning has been increasing.

Tall Oil Fatty Acids Division of PCA Formed

The formation of the Fatty Acids Division of the Pulp Chemicals Association to handle the problems of its tall oil fatty acids manufacturers was announced recently by R J Spitz, vice president of Newport Industries Co and chairman of the new Division.

In commenting on the activation of the new Division, Mr Spitz stated that, while fatty acid fractionation of tall oil did not have a long history, tall oil fatty acids have secured prompt acceptance in the field because of their uniform quality and the constantly increasing supply available. Tall oil fatty acids are being produced today at an annual rate of approximately 50,000 tons.

The initial program of the Division will feature promotion of greater use of tall oil fatty acids among such industries as those which manufacture textile oils, soaps, cutting oils, protective coatings, etc.

New Du Pont Production Units

Three new production units for the manufacture of hydrogen and anhydrous ammonia, aniline, and diphenylamine will be built by the Du Pont Company at the Repauno Works, Gibbstown, NJ.

The new facilities for aniline and diphenylamine will modernize the company's present process for these two products by replacing obsolete equipment. The unit for hydrogen and anhydrous ammonia will be the first one at the Repauno Works.

Construction will begin immediately and the units, which will be operated by the company's Explosives Department, are expected to be completed within two years. Operation of the new facilities is not expected to require any increase in employment.

The aniline capacity will be used for the new diphenylamine process and for sale to the company's customers. Diphenylamine is used in the manufacture of dyes and other items.

The design of these new units provides for the control and disposition of all waste materials.

Mitin Mothproofing Receives McCall's Use-Tested Tag

The first McCall's Use-Tested Tag for a chemical process has been awarded to Mitin Durable Mothproofing of the Geigy Chemical Corporation, according to a recent announcement from McCall's magazine.

Before granting the Tag, McCall's put the Mitin process through laboratory tests and practical home-use evaluations in the magazine's test rooms. McCall's editors and home economists checked Mitin-treated garments for the qualities that give long-term satisfaction to the consumer. After many washings and drycleanings, the materials treated with Mitin remained completely moth-repellent.

Throughout the testing, qualities of the process were singled out by McCall's editors as being "Features We Especially Like," and a summary of the testing was set forth on the tag.

Geigy Chemical Corporation regards McCall's Use-Tested Tag a valued third-party endorsement, acting as a silent salesman for Mitin-treated garments and a reliable buying guide for the consumer.

New Method of Transport for Anhydrous Aluminum Chloride

A new method of chemical transporation was made known recently by Solvay Process Division, Allied Chemical & Dye Corp, with the announcement that Elberta Brand anhydrous aluminum chloride will be shipped from the Company's Ransomville, NY, plant in specially designed, air-tight bulk trailers capable of carrying an 18-ton payload.

In the past this chemical, which readily attracts atmospheric moisture, had been available in the industry only in hermetically sealed steel drums. The Company states that introduction of bulk shipments represents a pioneering effort by Solvay to service the trade in a manner beyond the scope of drum shipments. According to Solvay, bulk shipments will provide substantial customer savings through lower materials handling costs.

The dump-tank semitrailers, which Solvay Process Division's Engineering Department developed, are owned and operated by Shipley Transfer, Inc, Reisterstown, Md. The vehicles incorporate a cylindrical steel body approximately 26 feet long. The one-man operated telescopic hoist will provide a maximum dumping angle of 45 degrees during the process of unloading.

Flanking framed samples of their top selling acids, sales representatives of Emery Industries' Fatty Acid Sales Department pose for camera during recent three-day sales meeting at the Terrace Hilton Hotel, Cincinnati. Theme of the meeting was "Operation Breakthrough", symbolizing new sales goals to be attained during the coming year. Company sales, advertising and marketing heads led discussions covering supporting services offered by Emery selling techniques, market conditions and the general competitive sales picture. Prime attention was given to the company's premium quality oleic and stearic acids.

Wyandotte's Michigan Oxide Products Plant on Stream at Capacity

Wyandotte Chemicals Corp's new oxide products plant, under construction in the last eight months at the company's North Works in Wyandotte, Mich, has gone on stream and is approaching rated capacity.

The new unit more than doubles the company's production of a wide range of ethylene oxide and propylene oxide derivatives.

The new multipurpose oxide products plant will enable the company to meet the rising demand for its Pluronic and Tetronic polyethers, according to Bert Cremers, general manager of Wyandotte's Michigan Alkali Division.

"Detergent needs alone have approximately doubled every year since we first introduced our polyols in 1950," Cremers reported. "The urethane grades, which our Research and Engineering Division developed within the last year as basic components in the whole field of polyurethane foams, already account for appreciable volume. Our development men, working with technicians in other companies, have applied the products to a number of new uses as emulsifying and dispersing agents in the compounding of latex coverings, oils and paints.

"These recent successful applications give some indication of the promising future ahead of these versatile polyethers."

Cremers said that although the new oxide products plant more than doubles previous capacity, the unit's basic design is such that capacity can be expanded rapidly as the product demand continues to increase.

Nopco Fiftieth Anniversary

Nopco Chemical Co, New Jersey producer of processing chemicals, urethane foams and vitamin products, recently celebrated its fiftieth anniversary with a look at its active history in chemical development.

Nopco was founded in 1907 by two men who were convinced of the marketable future of sulfonated oils, oils made water-soluble by chemical treatment. Recognizing the possibilities of these oils in both the textile and tanning industries, heavy users of water in their processing, Charles P Gulick and Arthur Philips, Nopco's founders, instituted a broad research program to develop new chemical aids for these industries.

Soon after its entry into the ranks of chemical manufacturers, Nopco became the first American company to produce a sulfonated cod oil, a product still a staple material in the processing of many types of leather. This was the initial item in a long list of "firsts" developed by Nopco through the years.

As the company developed new products, sales increased. Increased sales necessitated expansion of production facilities, and new facilities, as they were built, always included laboratory space for research and new-product development. Business expanded to a dozen industries and then to hundreds. New plants were built. New land was bought for future construction. Other subsidiary companies were bought or founded. And always new products were developed and research was widened. Today the company includes 5 plants, and offices and warehouses throughout the United States and Canada.

As an interesting sidelight on the wisdom of its new-product activities, Nopco reports that it has never had to withdraw a product from the market once introduced.

The textile industry, Nopco's first customer, is still one of the largest users of the company's products. It is claimed that any processing chemical needed by the textile mill operator can be obtained from Nopco. Chemicals that will be needed in the future will undergo investigation and evaluation by Nopco's textile chemists. In addition, the company maintains a staff of technical service experts.

Nopco was founded with an investment of $1,000. It is currently grossing 28 million dollars. Listed on the New York Stock Exchange since 1940, the company just paid its 109th consecutive dividend.

Versene Price Reduction

Price reductions on its Versene chelating agents have been announced by The Dow Chemical Company, Midland, Mich. Reductions on certain chelating agents will be as much as 20 percent.

Concurrently with the price reductions, Dow announced increased production capacity at its Freeport, Texas, plant and indicated that additional capacity is anticipated.

The greatest percentage cut will be made in the price of Versene 100, the most widely used chelating agent in the series. Decreases will become effective on many other Versene products including reductions of five cents per pound on Versene in acid, powder, beads and flake form.

Simultaneous with the lower price schedule, Dow is simplifying Versene pricing to conform to a commodity rather than a speciality basis.

A price reduction in June, 1957, coincided with the initial operation of the Freeport facilities. Prior to that date, all Dow production of chelating agents was centered in Framingham, Massachusetts.

The eventual transfer of all Versene manufacturing operations to Freeport is anticipated as larger plant capacity becomes available. Laboratory facilities will be maintained in Framingham, however.

Dow maintains stock points for the Versene products at Chicago, Ill; Midland, Mich; Port Newark, NJ, and North Charleston, SC. The products may also be purchased through a distributor organization with 39 nationwide sales outlets.

Sun Chemical Sells Stearate Department to Witco

The third major step in Sun Chemical Corporation's program for strengthening and integrating its 26 divisions has been completed with the sale of Sun's stearate business to the Witco Chemical Co. This stearate department, operated by the corporation's Warwick Chemical division, was disposed of since it was an unrelated business.

Last year, Sun Chemical purchased Bensing Bros & Deeney Co to obtain an integrated flexographic ink company serving the packaging industry. Later it bought Ansbacher-Siegle Corporation, to provide Sun's ink and paint divisions with a controllable source for organic pigments.

The sale of the stearate department will permit Warwick Chemical to concentrate on the development of organic chemical products for the textile and paper industries.

Warwick Chemical division is a producer of Prym and Warcoset textile resins, Impregnole and Norane water repellents. The division's expanded program for 1958 includes gradual increased activities in the fields of textile chemicals and Suntone textile printing colors, as well as plans for heavy promotion of its water repellents and wash and wear finishes for the textile industry.

Witco Chemical Company will assume and continue operation of the stearate plant at Wood River Junction, RI. This addition means that Witco now has four stearate producing plants in the United States and one in Canada.

Sales-Service Responsibility of Scott Testers (Southern), Inc Extended

Scott Testers, Inc, Providence, has announced the appointment of Scott Testers (Southern), Inc as representative for both sales engineering and equipment servicing for the entire southeastern area comprising Alabama, Georgia, Kentucky, the Carolinas, Tennessee and Virginia. Scott Testers (Southern), Inc maintains sales offices and complete servicing center consisting of machine shop and comprehensive parts stock at Asheville Highway, Spartanburg, S C, under the direction of John E Hargreaves, general manager. The extension of their sales and servicing responsibility to include the entire area follows upon the decision of John M Klinck to retire from active business on December 31, 1957 after serving as Scott Testers' representative in Georgia, North Carolina and South Carolina since the early 1930's.

Turbo Names Southern Sales Agent

Turbo Machine Co, Lansdale, Pa, has announced the appointment of Parrott & Ballentine, Greenville, SC, as its exclusive sales agent in the South for its entire line of textile machinery. The recent purchase of Smith-Drum Co added considerably to the line of textile machinery now manufactured by Turbo.

Turbo Machine Co manufactures hosiery preboarding machinery; hosiery dyeing and finishing machines; heat setting machines for synthetic fibers; sweater setting machines; staplers and crimpers for synthetic tow processing; shearing and finishing machines for woolen worsted and high pile fabrics.

The Smith-Drum Division of Turbo will continue to manufacture hosiery and sweater dyeing machinery, hosiery conveyor dryers, skein dyeing machinery, raw stock dyeing machinery, high-temperature package and beam dyeing, extracting and drying equipment.

Parrott & Ballentine, with sales offices in Greenville, and Burlington, NC, are Southern sales agents for several firms manufacturing textile dyeing, drying and finishing equipment.

CATCC Symposiam on Textile Technology

A new series of symposia on "Theories and Principles of Dyeing" under the auspices of the Quebec Section, Canadian Association of Textile Colourists and Chemists, commenced on January 17th with discussion of the topic "Thermodynamics and Kinetics of Dyeing" by Howard J White Jr, director of research, Textile Research Institute.

The schedule for the remaining topics, each of which will be discussed at Ciba Company's Conference Room, 1235 McGill College Av, Montreal, is as follows:

Feb 14, 7:30 pm: "Theories and Principles of Dyeing Acid Colors"—Emery I Valko, associate professor, Division of Chemistry, Lowell Technological Institute

Mar 7, 7:30 pm: "Theories and Principles of Dyeing Direct Colors"—Robert A Brooks, head, Research Division, Jackson Laboratory, E I du-Pont de Nemours & Co, Inc.

April 11, 7:30 pm: "Theories and Principles of Dyeing Pigment Colors" —Roy A Pizzarello, research director, organic chemicals and colorants, Interchemical Corp.

Wachter Urges Standards for Consumer Acceptance

"There is nothing wrong with textiles that confidence won't cure . . . confidence on the part of the industry and on the part of the consumer buying its products." So declared Arthur R Wachter, manager of Converting Relations for American Viscose Corporation, as he addressed the Canadian Association of Textile Colourists and Chemists at McGill University last month on the subject of "Standards for Consumer Acceptance."

Mr Wachter, in describing the various quality standards set in the industry, emphasized that "no one, not even an expert, can tell the difference between properly processed or poorly processed fabrics by looking at them or by feeling them. Only a laboratry test, based on a standard," he continued, "can reveal or predict what is good and what is bad."

Relating the importance of telling the consumer what a particular end product will do, Mr Wachter traced the development of "definitions of performance", from the early Crown Test Plan, through the adoption of the L22 code of American Standards Association.

Mr Wachter urged his audience to "get behind the standard movement, work for it, publicize it, become associated with it, and before too long all of textile's customers will have confidence in our products and in our industry."

New OMCC Liquid Caustic Terminal

A storage and distribution terminal for liquid caustic soda has been established at Bedford Park, Ill, outside of Chicago, by the Industrial Chemicals division of Olin Mathieson Chemical Corp.

The terminal will make Olin Mathieson competitive in delivery service on liquid caustic in the Chicago area. Shipments from the terminal to tank car and tank truck users reportedly will be made at the current delivered cost from established competitive producing points.

Located on the Chicago Sanitary and Ship Canal, Archer Avenue and Roberts Road, the terminal will receive 50 percent liquid caustic soda by barge from Olin Mathieson's several producing points on inland waterways.

The facility consists of tank storage, barge unloading and tank truck and railroad tank car loading and weighing equipment. It is leased by Olin Mathieson from General American Tank Storage Terminals, a division of General American Transportation Corp.

Process for Continuous Dyeing of Arnel/Cellulosic Blends

A practical, economical process for the continuous dyeing of Arnel triacetate in blends and combinations with cotton and/or rayon, utilizing available commercial cotton dyehouse equipment, was announced recently by Celanese Corporation of America.

Wide variety in color styling possibilities and a high degree of washfastness at economical costs reportedly characterize the process. Dyeing is said to be approximately three times as fast by this method compared to conventional synthetic dyehouse procedures.

An important phase of the process is dissolving the disperse dyes in a solvent which is water soluble and then padding the water solution of the dye onto the fabric. Uniform distribution of the dyes and subsequent steaming causes migration of color from cotton and rayon to Arnel. Continuous vat dyeing of cotton or rayon portions may be accomplished by the use of Williams units after the Arnel has been dyed. Procion and Cibacrons are applied in a continuous manner before Arnel is dyed.

Samples of material processed by this method were displayed in the Celanese booth at the AATCC Convention in Boston, November 14-16. Additional information on the process is available in Technical Bulletin TD-18 prepared by the Textile Division of Celanese Corporation of America in Charlotte, NC.

"Do-It-Yourself" Vat-dyeing Kit

Hospitals, hotels, and other institutions reportedly may now add color easily and economically to their linens, napery, and other institutional fabrics through use of the new "Sani-Vat" Dye Kit. This kit, designed to allow vat dyeing to be done with normal institutional laundry equipment, was developed by American Aniline Products, a unit of the Chemical Division, Koppers Company, Inc.

Basis of the new development is a unique process for applying vat dyes to fabrics quickly, easily and with uniform results. Since no special equipment is required, the simple, four-step "do-it-yourself" dyeing operation can be completed in little more than an hour's time, it is claimed.

"Sani-Vat" Dye Kit

Vat dyes are generally regarded as superior to other types of fabric dyes from the standpoint of colorfastness under conditions of frequent washing, light exposure, bleaching, drycleaning, and hot pressing. With the addition of vat-dye color, it is claimed that linens, napery, and other institutional fabrics can be given individuality, warmth, and luxury not usually associated with similar fabrics of stark white color.

Another cited advantage of the new development, and the variety of colors it offers for use, is that fabrics for specific purposes, or for use in a particular location can be color-coded for easy identification. It is suggested that this saves time and confusion during subsequent launderings and in the efficient handling and storage of linens and other institutional fabrics.

In each "Sani-Vat" Dye kit, the dye and dye assistants are individually packaged in polyethylene film bags. The kits are available in two sizes for fixed loads of fabrics to be dyed—either 100- or 200-pound dry-weight loads. Also included in each kit are complete instructions for the easy, four-step dyeing process.

Designed primarily for the convenient use of institutional service staffs, the "Sani-Vat" Dye kits are being offered in various shades of yellow, gray, tan, beige, pink, violet, mauve, blue, green, navy and brown.

Photograph shows the individually packaged ingredients of the new "Sani-Vat" Dye kit, which enables vat-dyeing to be carried out in four steps utilizing ordinary institutional laundry equipment:

Step 1—Pour dye (package #1) into machine while filling with 75 to 150 gallons of water at about 140°F. (This would be equivalent to a level of 12 inches in a 42- x 84-inch washer, allowing for water of saturation of fabrics.).

Step 2—Dissolve the caustic soda (package #2) in a few gallons of water in a pail. Add the caustic soda to the machine. Allow machine to run five minutes, then add linens to be dyed.

Step 3—Add sodium hydrosulfite (package #3) to the machine. Run washer 30 to 45 minutes at about 140°F.

Step 4—Drop dyebath. Rinse once with cold water for two to three minutes at 12-inch level. Refill to 12-inch level with full hot water (not over 160°F). Add sodium perborate (package #4) to machine. Run 10 minutes. Follow this step with a regular white-work washing formula.

Further information and complete color charts can be obtained from American Aniline Products, Chemical Division, Koppers Company, Inc, 901 Koppers Building, Pittsburgh 19, Pa.

CSI Fabric Burn Hole Tester

Fabric Burn Hole Tester

Custom Scientific Instruments, Inc, Kearny, NJ, has added a new tester to determine the resistance to heat of fabrics, upholstery, plastics, etc. This unit, developed by the R&D Command of QM Research Center, will be known as the "Fabric Burn Hole Tester."

The apparatus consists of a small heat source capable of being maintained at constant temperature. It can be made to impinge upon the sample, which is in a horizontal position and is under no tension or pressure prior to the impingement.

Lumicrease/Cuprofix Navy GLA paf; Grey 3LR Pat

Lumicrease/Cuprofix Navy GLA paf, recently added to the Sandoz Lumicrease line of fast-to-light direct dyes, is being especially recommended by the manufacturer for use on decorative and automotive fabrics. Fastness to light, water, and perspiration are said to be more than sufficient to meet the most severe requirements for these applications. Cuprofix, Sandofix or U F resin treatments reportedly cause no loss in the favorable ratings of this dye.

Lumicrease/Cuprofix Grey 3LR Pat, a direct dye said to be unlike anything on the market, is the second grey recently added to the Sandoz line of Lumicrease colors. Fastness to light, water, and perspiration are said to be exceptional. Ratings after treatment with U F resin, Cuprofix or Sandofix are reported high. Lumicrease Grey 3LR Pat is said to possess outstanding solubility, and is therefore particularly well suited for application in pad dyeing. It is stated that high fastness to light, and satisfactory cotton and rayon union recommend it for automotive and decorative fabric applications. Leaflets containing full information may be obtained from Sandoz District Offices.

Crest Retard NM

Crest Chemical Corporation, 225 Emmet St, Newark, NJ, has announced the introduction of Crest Retard NM, an agent used to obtain level application of cation-active dyes to the new, "more dyeable" Orlon.

Crest Retard NM is said to prevent the rapid exhaustion of the dyestuff at temperatures above 200°F, thereby enabling the dyer to obtain uniform, level dyeings. By varying the amount of Crest Retard NM, it is said to be possible to vary the time required to exhaust the dyestuff over a broad range. The amounts required depend upon the depth of shade wanted, the percent dyestuff used, and the desired time of dyeing.

Crest Retard NM is available as a readily soluble amber-colored liquid. Further information and samples are available upon request.

Depco Carrier D A Depco Dye Assist O W

De Paul Chemical Co, 44-27 Purvis St, Long Island City, NY, has announced its two latest dyeing assistants, Depco Carrier D A and Depco Dye Assist OW.

Depco Carrier D A is a new type of carrier used in the dyeing of Dacron and Dacron blends. It is said to completely eliminate the spotting problem and cut out complicated procedures by offering a simple one-step process. It reportedly gives outstanding color yields and is relatively nontoxic.

Depco Dye Assist O W is a newly developed product used in the dyeing of Orlon and wool. It is used as a dye assistant in the dyeing of Orlon particularly when both basic and disperse colors are used together. It reportedly prevents tarring and precipitation of the dyestuffs, and also aids greatly in insuring the levelness of the dyeing. When used in dyeing of raw stock wool, Depco Dye Assist OW will prevent tippy dyeing, it is claimed.

Maxilon Red B L

What has been described as the first true red for acrylic fibers, especially Orlon, has been added to its Maxilon series by Geigy Dyestuffs. Called Maxilon Red BL, the new dyestuff produces a bright shade somewhat on a bluish cast. The outstanding feature of the new color is said to be its extremely good lightfastness, rated as 7-8. The lightfastness is said to hold for all depths of shades from pastels to full reds.

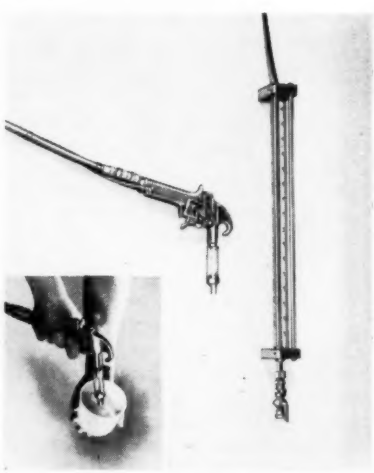
The new red acrylic dyestuff also is said to exhibit very good fastness in wet treatment, decatizing, heat setting, permanent pleating, and good reservation of wool and cellulosic fibers. High-temperature dyeing methods are recommended by Geigy and no swelling agents are called for.

Maxilon Red BL reportedly is well adapted for use in combination with Geigy's Maxilon Blue GLA and RLA, the introduction of which was recently announced, and also with other basic colors now on the market.

New Antistatic Devices for Cleaning

Simco Company, 920 Walnut Street, Lansdale, Pa, has introduced two new types of static eliminating equipment, specifically designed for cleaning dust and dirt from textile materials and all other types of surfaces to which the dust is being attracted and held electrostatically. In the new static bars, provision reportedly is made for simultaneously blowing off the dirt and neutralizing the static charges on both the dirt and the part being cleaned. This simultaneous action is said to be much more effective than other cleaning methods, such as brushing or wiping; not only is the dust completely removed, but the electrostatic forces tending to re-attract it to the part are eliminated, it is claimed.

One of the new static bars, the Air Type Shockless Bar, incorporates an air tube with holes opposite each point and can be adjusted in length to fit the application. The other, called the Neutrostat Air Gun, is a hand-held compressed air gun with a static eliminator built into the nozzle. A small power pack, operated from AC service, will energize a number of the Air Type Shockless Bars or the Neutrostat Air Guns.



New Simco Antistatic Devices

New Astrazons

The following are new dyestuffs now being released to the trade by Verona Dyestuffs, Union, NJ:

Astrazon Yellow 7GLL—This new homogeneous cationic dyestuff for the dyeing and printing of polyacrylic fibers produces a bright, greenish shade. It is said to offer very good lightfastness and wetfastness even in pale shades. Recommended by Verona also for the printing of acetate.

Astrazon Red BBL—This new bluish red homogeneous cationic dyestuff for the dyeing of polyacrylic fiber separately possesses very good light- and wetfastness properties. It is said to be particularly suitable for the production of light, fast shades in combination with other Astrazon "L" dyestuffs. It is also recommended by Verona for the dyeing of full shades of red and bordeaux.

Astrazon Olive Green BL—This new olive green homogeneous cationic dyestuff for the dyeing of polyacrylic fibers is said to possess very good light- and wetfastness properties. It is particularly recommended for the production of mode shades in combination with other Astrazon "L" types.

Astrazon Blue RL and 3RL—These new homogeneous cationic dyestuffs for the dyeing of polyacrylic fibers are said to possess very good light- and wetfastness properties. They are recommended for the production of fast shades in combination with other Astrazon "L" types. Also recommended for the dyeing of acetate.

New Amberlites

Fisher Scientific Co, 316 Fisher Bldg, Pittsburgh 19, Pa, is offering two new Amberlites (Rohm & Haas Co's ion-exchange resins) with specific utility in chromatographic separation and identification, especially of the components of complex amino acid mixtures. These Amberlites have a particle size range of 400-600 mesh (U S Standard Screens). Thus, though flow rate is diminished, *exceptionally sharp separations* are achieved by virtue of their great surface area, it is claimed.

Amberlite CG-120 (400-600 mesh) is a strongly acidic cation-exchange resin in sodium form. Catalog number is A-932. Price: $11.75 lb.

Amberlite CG-50 (400-600 mesh) is a weakly acidic cation-exchange resin in hydrogen form. Catalog number: A-933. Price: $11.75 lb.

Conco-Softener P C

Continental Chemical Co, 198 Twenty-first Ave, Paterson, N J is now in full production on Conco-Softener P C, a versatile softener for all types of fabrics and yarns. It is described as a modified ester, nonyellowing type with lubricity improving sewability with good resistance to abrasion, and antistatic properties.

Du Pont Dye Formulations for Colors of Fashion Interest

With tinted hosiery established as a major fashion platform in hosiery sales promotion, interest has increased in development of iridescent shades as an extension and strengthening of the basic color theme in hosiery marketing.

As an aid to the hosiery industry, dye formulations for colors of fashion interest have been developed in Du Pont laboratories. Color names correspond to those shown in the Fall-Winter 1957 Season Shade Card of the Color Association of the United States (formerly the Textile Color Card Association).

Each of the following formulations is to be dyed by conventional hosiery dyeing methods using Duponol D paste surface-active agent and trisodium phosphate (TSP):

Blushgleam
0.25 percent Acetamine Yellow N
0.25 percent Celanthrene Red Violet R

French Cafe
0.5 percent Acetamine Yellow N
0.5 percent Celanthrene Red Violet R
0.25 percent Celanthrene Violet CB

Paris Taupe
0.3 percent Acetamine Yellow N
0.36 percent Celanthrene Red Violet R
0.18 percent Celanthrene Violet CB

Beige Glaze
0.32 percent Acetamine Yellow N
0.36 percent Celanthrene Red Violet R
0.08 percent Celanthrene Violet CB

Sungem
0.15 percent Acetamine Yellow N
0.15 percent Celanthrene Red Violet R
0.01 percent Acetamine Scarlet B

Rose Magic
0.3 percent Acetamine Yellow N
0.36 percent Celanthrene Red Violet R

Vinalast Fabrics Characteristics Aided by Pliovic AO

Vinalast plastic-coated fabrics, characterized by excellent pliability, water-repellent qualities and resistance to chipping, cracking and peeling, currently are finding extensive use in the production of automobile seat covers.

The material selected by Marbek, Inc, Brooklyn, NY, for its plastic coating operations is Pliovic AO, a vinyl dispersion resin produced by the Chemical Division of The Goodyear Tire & Rubber Company.

Goodyear production methods produce a resin which is said to be essentially free from soluble residues, resulting in reduced water absorption and improved light and heat stability characteristics.

A plastisol formulation based on Pliovic AO is used by Marbek to knife-coat osnaburg and drill fabrics. Use of the resin, Marbek reports, requires lower and less critical fusion and gel temperatures, thus providing a faster, more efficient production operation.

Tests performed by a leading textile testing company, comparing Vinalast with other materials, reportedly showed the Marbek fabric to have superior flexibility, hand, adhesive properties and fade resistance.

Manufactured in 25 colors and shades, Vinalast is distributed nationally for seat cover production through leading automotive jobbers.

Flaked Stearyl Alcohol Bagged in Exact Quantities Required

Hodag Chemical Corp has announced that a flaked, technical grade stearyl alcohol is now being offered bagged in the exact quantity requested by the user. This service is designed to eliminate scooping, weighing, drum handling, storage problems, guesswork and waste. The user merely adds the required amount of stearyl alcohol flakes, prepackaged by Hodag, and discards the paper bag.

Hodag's flaked stearyl alcohol was developed as an antifoam additive for fermentation operations. This product is also used as an intermediate for textile finishing agents and detergents. The product can be oxidized or esterified.

An information sheet listing specifications, physical and chemical properties, and other data on flaked stearyl alcohol is available on request from Hodag Chemical Corp, 7247 N Central Park, Chicago 45, Ill.

• NAMES IN THE NEWS •

Condon

John A Condon Jr, formerly assistant superintendent of dyeing at Pacific Mills, Lawrence, Mass, has been appointed textile chemical sales representative for the New England area for the Organic Chemical Sales Department of Emery Industries, Inc. He will be responsible for the sales of Emery's Twitchell and Emersoft lines in New England and the mid-Atlantic areas.

The election of **Walter F Wolfe** as vice president and **Albro N Dana** as assistant treasurer of Indian Head Mills, Inc has been announced.

Mr Wolfe is general manager of the company's Franklin Process Division, which operates yarn dyeing and finishing plants at Providence, RI; Philadelphia, Pa.; Greenville, SC; and Chattanooga, Tenn, and a spinning mill and yarn bleachery at Fingerville, SC. Mr Wolfe was formerly president of Franklin Process Company, the business of which was recently purchased by Indian Head Mills.

Mr Dana, formerly senior vice president and treasurer of Franklin Process Company, will continue to serve as principal financial officer of the Franklin Process Division.

The promotion of **David F Lowry** to manager of the recently created new products department of the Polyco-Monomer Department and the appointment of **Robert S Buffam** as a project engineer in the Polyco-Monomer Department have been announced by Borden Company's Chemical Division.

Mr Lowry, formerly assistant sales manager of the department, will be responsible for sales development of new products and will coordinate laboratory and sales objectives.

Mr Buffam, formerly engineering manager of the New England Confectionary Company, will be located in Leominster, Mass, the department's engineering headquarters.

Shailer

Lawrence L Shailer Jr has been appointed to the newly created position of manager of textile chemicals sales development for B F Goodrich Chemical Co. He will report to general merchandising manager **A I Brandt** and will be responsible for promoting and coordinating the sales of company products—excepting fibers and color pigments—to the textile industry through existing departmental sales groups.

Mr Shailer has been with B F Goodrich since 1943, having served most recently as a senior product engineer in charge of market development of hydrophilic materials.

C A Bentz Jr has been appointed group leader in the Development Department of Union Carbide Chemicals Co, Division of Union Carbide Corp. He previously served as technical editor in the Development Department.

Bertrand W Hayward, president of Philadelphia Textile Institute, was honored at a testimonial dinner held at the Madison House, Philadelphia, Pa, on Dec 12th, marking his tenth year with the Institute.

Russell C Osborne, R C Osborne and Co, headed the committee that originated the idea and also served as master of ceremonies. He was assisted by **Julius Zieget**, PTI treasurer, and **Alan M Richter**, PTI's director of public relations.

Mr Hayward was presented with a silver tray upon which were inscribed the names of those in attendance. The presentation was made by **Everett L Kent**, Kent Mfg Co, president of the PTI Foundation. **W Lyle Holmes Jr**, Archibald Holmes & Sons, chairman of the board of trustees of the Institute, proposed the toast.

Because of space limitations, invitations were limited to trustees of the Institute, its Foundation, the Education Committee, alumni officers, and the Institute staff. Forty-four guests were in attendance.

Khoury

Freddy Khoury, formerly with British Nylon Spinners, Ltd of Great Britain, has joined the research staff of Fabric Research Laboratories, Inc, Dedham, Mass, as a senior associate.

The board of directors of the Virginia Smelting Company, with main offices and plant at West Norfolk, Va, recently elected **Augustus H Eustis** to fill the newly created position of chairman of the board. Mr Eustis has been president of the company for the past twenty-five years.

At the same meeting, **A Kenneth Scribner**, formerly vice president and general manager, was elected president. Mr Scribner has been associated with the company since 1921. He will continue as chief operating executive of this chemical company.

Three of the several newly created offices were filled as follows: **R F Lotz**, vice president-comptroller (formerly comptroller); **Peter Eustis**, vice president-secretary (formerly secretary); and **D W Duncan**, vice president-manufacturing (formerly plant manager). **F A Eustis** remains treasurer of the company, and **F A Eustis II** was elected an assistant treasurer.

William E Hanford, assistant to the president for research, Olin Mathieson Chemical Corp, received honorary membership in the American Institute of Chemists at a dinner meeting held Dec 12 at the Hotel Commodore, New York, NY. He addressed the group on "Need for Prescience in Organic Chemistry".

Donald A McQuarrie and **Maurice I Seifer**, members of the graduating class at Lowell Technological Institute, have been elected to Tau Epsilon Sigma, scholastic honor society, on the basis of outstanding scholastic achievement and character.

McQuarrie is enrolled in the chemistry course; Seifer is a major in textile chemistry.

Barry

David T Barry, formerly director of marketing, has been appointed to the newly created position of general sales manager of Stowe-Woodward, Inc. In this new post he will supervise and administer all sales functions for the Company's three divisions, including the custom rubber-covered roll division.

Solvay Process Div, Allied Chemical & Dye Corp, has announced the appointment of **Wilbur H Brumfield** and **Cortez P Hackett** as vice presidents. Mr Brumfield, who was transferred to Solvay's New York Executive Office as assistant to the president in 1957, assumes increased administrative and executive duties in the New York office. As vice president located in Syracuse, Mr Hackett, formerly Solvay's director of development, will be in charge of all Solvay's operating and development department functions.

Other changes include the naming of **Clyde A Kitto**, formerly manager of the Syracuse plant, to the post of director of operations; **Arnold Hanchett**, formerly assistant director of development, to director of development; and **M James Campbell**, formerly assistant manager of the plant, to manager of Solvay's Syracuse plant. **H G Phillips Jr**, manager of Solvay's Pittsburgh branch since 1948, has been named manager, Syracuse sales branch, succeeding **William E Hess**, who retired December 31st after 27 years in the post. **John B Green**, formerly assistant comptroller, has been named comptroller, succeeding **John J Bryers**, who has retired after a half century of service.

Newport Industries Co, a division of Heyden Newport Chemical Corp, has appointed **Edwin G De Laney** as Philadelphia district manager and **Christy A Brier** as technical sales representative for Northern New Jersey.

Mr De Laney joined Newport Industries in 1953 and has been serving as technical sales representative in the New York district. Mr Brier has been associated with the paint industry in the New York area for more than 20 years.

Clary

Truman Clary has been named director of research and development for Eastern Color & Chemical Co, Providence, RI, where he will direct and further the Company's products development.

Mr Clary had been associated with Warwick Chemical Co for the past 10 years in the Industrial and Textile Chemicals Dept.

Recent staff appointments at American Cyanamid Company's Santa Rosa plant, which will produce the Company's Creslan acrylic fiber upon its completion late this year, include the following: **Jason M Salsbury**, formerly manager of textile chemicals research at the Bound Brook Laboratories, now manager, technical department; **Robert B Latimer**, formerly in the dyestuffs department of the Organic Chemicals Division at Bound Brook, now manager, production department; **Richard W Leins**, former director of engineering for Courtaulds, Inc, now chief engineer; **A C Healey**, former staff engineer for H K Ferguson, Inc, now chief project engineer; **F A Edmundson**, former assistant chief engineer for American Bemberg Division of Beaunit Mills, Inc, now maintenance superintendent; and **James J Pinke**, formerly assistant maintenance superintendent at Cyanamid's Lederle Laboratories Division at Pearl River, now utilities superintendent.

Plant managers previously named to the staff of **N H Marsh**, plant manager, are **W N Sellers**, who heads the services department, and **Wayne T Kent**, manager of the personnel relations department.

Norman L Levin has been named senior sales and merchandising representative for Cyanamid's Fibers Div. He joins the sales staff for Creslan from a post as department manager for American Bleached Goods Co.

Samuel Pinanski, president and director of the American Theatres Corp, has been reelected chairman of the board of trustees at Lowell Technological Institute. **Doran S Lyons**, manager, Kidder, Peabody & Co, was elected to the office of vice chairman.

Ekholm

The retirement of **Karl Ivar Ekholm**, veteran dye salesman and sales executive of National Aniline Division, Allied Chemical & Dye Corporation, has been announced. Mr Ekholm, assistant director—dyestuff sales, has been with the Company for the past 34 years.

Mr Ekholm, a native of Ripsa, Sweden, received his early education in that country at Strängnäs College, and his technical education in chemical engineering and paper chemistry at Chalmers Technical University in Sweden and at Coethen Polytechnicum in Germany. After a number of years' experience in paper mills and dyestuff plants in those countries, he came to the United States in 1923 and joined the technical staff of National Aniline Division as a paper chemist. Since 1927, his activities have been in technical sales and service, principally involving the pulp and paper industry, first as paper chemist and salesman and, after 1933, as assistant domestic sales manager. His position as assistant director—dyestuff sales, dated from January 1, 1956.

Mr and Mrs Elkholm plan to travel in this country and abroad, and will continue their present residence at 226 26th Street, Flushing 64, New York.

The board of directors of Harris Research Laboratories, Inc has elected **Milton Harris**, president; **Alfred E Brown**, vice president; and **Louis R Mizell**, assistant treasurer of the organization.

The following promotions were also announced: **Arnold M Sookne**, associate director; and **Lyman E Fourt**, **Anthony M Schwartz** and Mr Mizell, assistant directors.

Charles J Geyer Jr has been appointed director of the Technical and Textile Service Dept, American Viscose Corp. He succeeds **Karl M Currier**, who will report to **Gerald S Tomkins**, Avisco president, on special projects until his retirement June 1st.

Dr Geyer last May was appointed assistant director of the newly created Technical and Textile Service Department. He joined Avisco in 1941.

Mr Currier joined Avisco in 1931.

Emery I Valko, formerly vice president in charge of research and development at Onyx Oil & Chemical Co, has been appointed associate professor in the Division of Chemistry, Lowell Technological Institute.

Hugo Helburn, founder of Apex Chemical Co, Inc, Elizabethport, NJ, recently celebrated his 99th birthday. Mr Helburn is still alert and on the job every day of the week.

Two new section managers at the Wilmington headquarters and a new assistant manager for the Chicago district have been anounced by Du Pont's Dyes and Chemicals Division in a series of personnel changes effective January 1, 1958.

John J Barnhardt Jr, for the last five years dye sales representative in Greensboro, NC, becomes manager of the textile section of the dyes division in Wilmington, while **Raymond L Burnett**, dye sales representative in Chicago district since 1955, has been named manager of the lakes and leather section. At the same time, **J Edward Dempsey**, who for the last six months has been manager of the lakes, leather, and paper section, takes over the position of assistant manager of the Chicago district office of the Dyes and Chemicals Division.

In other changes, also effective January 1, **John M Remsen**, for the last six months manager of the textile section of the dyes division, has been named supervisor of dye sales in the Chicago district, while **J Donald Martone** has been transferred from the Chicago office to the intermediates section of the chemicals division in Wilmington.

Irving Rosen has been appointed vice president in charge of sales for Aceto Chemical Co, Inc, Flushing, NY. He has been with the firm for almost five years, and in the past has been responsible for the market research and sales development of a number of new Aceto products.

Paisley Products, Inc, Division of Morningstar, Nicol, Inc, New York, has announced a reorganization of Eastern Paisley sales management personnel to integrate the sales staff of the Federal Adhesives Corp, a recent acquisition.

The following Eastern Paisley sales management appointments are now effective: Federal's **Philip M Liner**, Eastern sales manager; **H R Callahan**, administrative sales manager; **Arthur Mayer**, manager of Special Products Department; **Mortimer E Stern**, director of technical market development; **Edward Bearman**, until recently chief chemist, has assumed the post of manager, Adhesive Development Laboratory; **I G Nichol**, Paisley's assistant sales manager, has assumed new responsibility with direct supervision of the combined New York metropolitan area sales force; **Samuel Tisser**, manager, Latex & Plastisol Department; and **Harold Stone** retains his post as manager, Adex Manufacturing Div in Baltimore, Md, which will now produce the Paisley Adhesive line in addition to their existing product line.

The following chemistry and textile scholarship recipients at Lowell Technological Institute have been announced by Dean Richard W Ivers:

Chemistry majors—**Robert Davis**, Ciba Co, Inc award of $500; **George Lynn**, Ralph E Hale memorial scholarship of $250 established by the Northern New England Section, AATCC; **Mario Santarelli**, US Rubber Co award of $500; **Kathryn Connors**, Interchemical Corp award of $250; **Robert Lipps**, Alliance Color and Chemical Co award of $500.

Textile scholarship winners—**Robert Duga**, Owens-Corning Fiberglas Corp award of $500 and full tuition; **Robert Hodge**, The Chemstrand Corp scholarship of $500; **John Carter**, Burlington Industries Foundation scholarship of $500; **Philip Swanson**, American Viscose Corp scholarship of $500; **Roger Ferry**, **Albert Harvey** and **Peter Haft**, Gehring Memorial Foundation scholarships of $75 per semester.

TECHNICAL LITERATURE

CUSTOM WORK, SERVICE ENGINEERING, INSTRUMENTS & EQUIPMENT FOR RESEARCH, CONTROL & PRODUCTION—*Custom Scientific Instruments Inc, Kearny, NJ*———New catalog No. 58 contains illustrations and brief descriptions of 50 different units, including testing and calibration instruments and fixtures that appear in ASTM Designation, Federal, Military and other specifications.

COTTON AND ORLON BLENDS IN YARNS—*Lowell Technological Institute, Lowell, Mass*———This quarterly bulletin of the Institute was compiled from work done by John A Goodwin, head of the cotton section in LTI's Division of Textiles.

SERVING INDUSTRY—*Philadelphia Quartz Co, 1158 Public Ledger Bldg, Philadelphia 6, Pa*———This 16-page catalog in miniature lists many of the important liquid and dry sodium and potassium silicates with their physical and chemical properties. Discussions treat such applications as soap and detergent builders, sizes and coatings, etc. Chart lists pH values and chief advantages in various processes together with the silicate property applicable to the use cited.

STATISTICAL SUMMARY NO. 2—*$1.00; Manufacturing Chemists' Assoc, Inc, 1625 Eye St, NW, Washington 6, DC*———This second supplement to the fourth edition of the Chemical Statistics Handbook is part of a series of chemical industry statistical summaries. It contains up-to-date information in tabular form on wage, hour, employment, production and price trends in the chemical industry as compared with all manufacturing through the first six months of 1957.

It includes also chemical production data from the final bulletins of the 1954 Census of Manufactures released in 1957 by the Bureau of the Census.

The original basic reference work, the 412-page Chemical Statistics Handbook, was published in 1955. It contains a variety of official information and statistics relating to the chemicals and allied products industry for 1950-53 with partial data for the first six months of 1954. This may be obtained from MCA for $3.00.

General Calendar

AMERICAN OIL CHEMISTS SOCIETY
April 21-23 (49th Annual Meeting, Peabody Hotel, Memphis, Tenn); July 14-18 (Short course on soaps and synthetic detergents, Princeton Inn, Princeton, NJ); Oct 20-22 (Sherman Hotel, Chicago); April 20-22, 1959 (Roosevelt Hotel, New Orleans, La); Sept 28-30 (Statler Hotel, Los Angeles, Calif)

AMERICAN SOCIETY FOR TESTING MATERIALS (COMMITTEE D-13)
Mar 18-21 (Spring Meeting, Sheraton Park Hotel, Washington, D C); Oct 14-17 (Sheraton McAlpin Hotel, New York, N Y)

THE DRYSALTERS CLUB OF NEW ENGLAND
Jan 20, May 2 (Hotel Vendome, Boston, Mass); June 20 (Outing—Wachusett Country Club, West Boylston, Mass)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
June 9-12 (National Conference on Materials Handling, Public Auditorium, Cleveland, O)

CANADIAN TEXTILE CONFERENCE
May 6-8 (Queen Elizabeth Hotel, Montreal, Quebec)

DIVISION OF CLOTHING AND TEXTILES IN EXTENSION, TEACHING AND RESEARCH, UNIVERSITY OF GEORGIA
Nov 7-8 (2nd Textile Seminar, Georgia Center for Countinuing Education, Athens, Ga)

THE FIBER SOCIETY
April 30-May 1 (The Clemson House, Clemson SC); Sept 9-10 (Montreal, Que)

INSTRUMENT SOCIETY OF AMERICA
May 12-14 (Analysis Instrumentation Division Symposium, Shamrock Hilton Hotel, Houston, Texas)

INTERNATIONAL TEXTILE MACHINERY EXHIBITION
Oct 12-15 (Belle Vue, Manchester, England)

DELTA KAPPA PHI FRATERNITY
April 24-26 (New Bedford Hotel, New Bedford, Mass)

INTER-SOCIETY COLOR COUNCIL
Mar 25-26 (27th Annual Meeting, Sheraton Park Hotel, Washington, DC)

LAUNDRY, DRYCLEANING AND ALLIED TRADES' EXHIBITION
July 17-26 (Olympia, London, England)